Prepared for the

Washington State
Department of Transportation

in cooperation with
U.S. Department of Transportation
Federal Highway Administration

Freight Efficiency & Competitiveness Phase I

Final Report

June 2006

Prepared By

Wilbur Smith Associates
Heffron Transportation
NohBell Group
RNO Group

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO.	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
WA-RD 646.1		

4. TITLE AND SUBTITLE	5. REPORT DATE
Freight Efficiency and Competitiveness Phase 1	6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
Thomas Jones, Sophie Hartshorn, Marni Heffron, Michael Siegmund, Tim Duffy, Arno Hart	

9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. WORK UNIT NO.
Wilbur Smith and Associates 600-108th Ave. NE, Suite 1020 Bellevue, WA 98004	11. CONTRACT OR GRANT NO. Y-9377

12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
Washington State Department of Transportation Office of Research and Library Services Olympia, Washington 98504-7372	Freight Research
	14. SPONSORING AGENCY CODE 405

15. SUPPLEMENTARY NOTES

This study was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.

16. ABSTRACT

The Freight Efficiency and Competitiveness Study provides a comprehensive look at the freight delivery supply chain of major industries in the Central Puget Sound region. The study pinpoints areas of inefficiency in the freight delivery system and provides data to support the creation of a strategic investment plan for Washington State's freight transportation system.

The report is organized into four sections,

1. Introduction and Executive Summary;
2. Overview of Target Supply Chains;
3. Issues, Constraints and Potential Remedies Based on Freight Interviews;
4. Constraints, Opportunities and Recommendations.

The research and analysis for this project included in depth interviews with key freight personnel in Washington State, industry research, and market analysis. These methods allowed a better understanding of the freight and supply chain issues of each industry. From this, the study was able to identify and quantify bottlenecks and deficiencies in the existing transportation system.

17. KEY WORDS	18. DISTRIBUTION STATEMENT
Freight, Efficiency, Competitiveness	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22616

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
None	None		N/A

Table of Contents

Section 1
Introduction and Executive Summary

Introduction

The purpose of the Freight Efficiency and Competitiveness Study is to provide a comprehensive look at the freight delivery supply chain of major manufacturing industries in the Central Puget Sound region. The goal of the study is to pinpoint areas of inefficiency in the freight transfer system and to provide data to support a strategic plan for Washington State's freight transportation system.

This requires a thorough understanding of *who* is using the freight system, *what* things they value most in a delivery system, and *where* the largest inefficiencies in the system exist. In order to gather this information, this study followed an industry outreach process that focused on three major manufacturing supply chains in the Central Puget Sound region: building and construction, processed foods, and aerospace.

This report is organized into four sections, of which this chapter is the first. The chapters include:

1. **Introduction and Executive Summary:** Outlines the key findings, and conclusions of the study.

2. **Overview of Target Supply Chain Sectors:** Introduces the three study industries, their role in the regional economy, and their relationship to study goals.

3. **Issues, Constraints, and Potential Remedies Based on Freight Interviews:** Synthesizes the outreach process and information gained through the process.

4. **Specific Constraints, Opportunities, and Recommendations:** Recommends specific actions that WSDOT and potential partners can pursue.

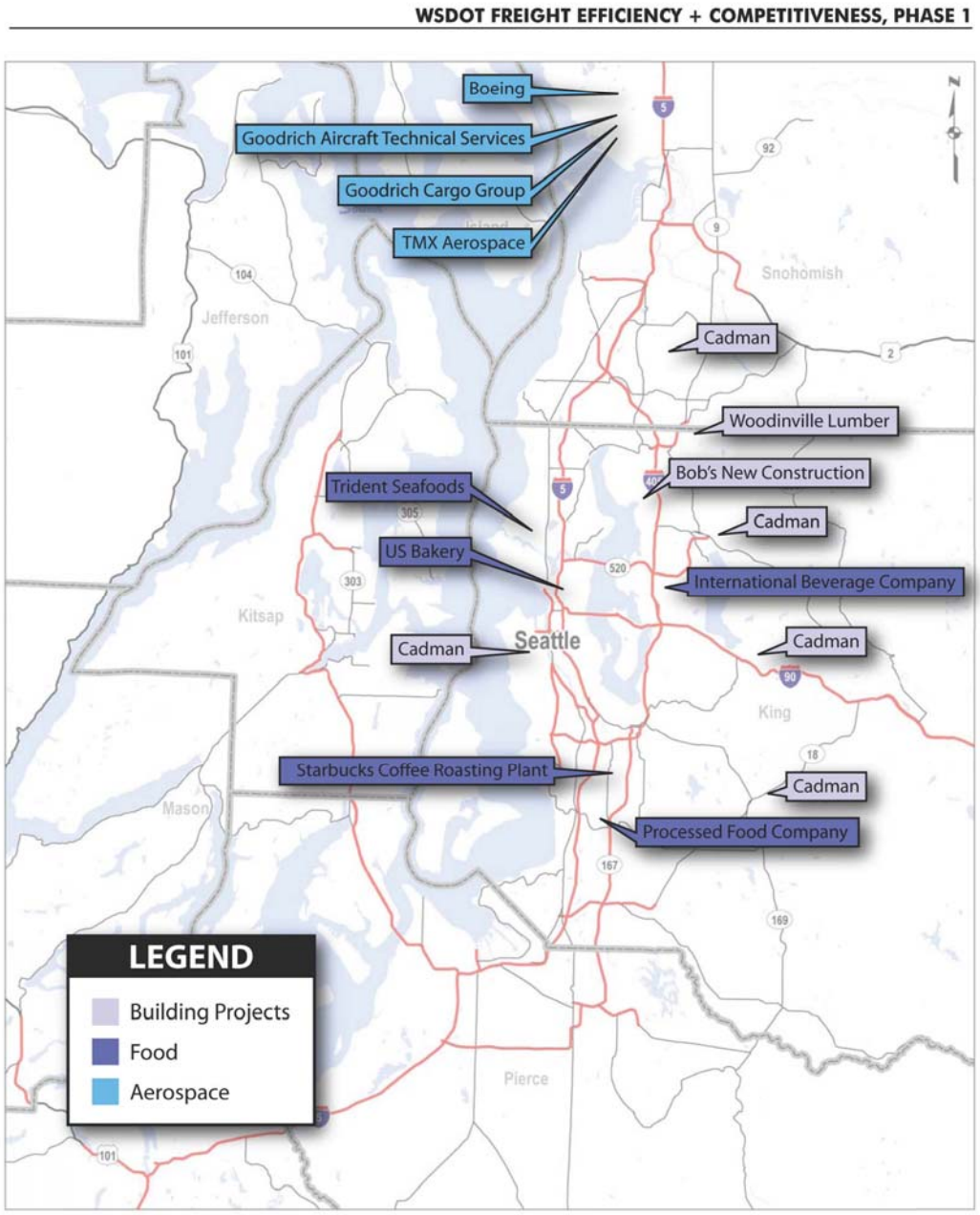
Summary of Findings

Exhibit 1 shows the name and location of the businesses that were interviewed for this study, as well their respective industrial sector. This map also shows the major highways that these businesses reported using most in their everyday business activities. Detailed interview summaries are provided for each business in the Appendix.

The following key findings are discussed in detail in the main body of the report. In general terms, they include the following insights:

- Most of the Puget Sound regions' industrial activity is located in the area from Seattle south to Pierce County, with concentrations in the Green River Valley (the region which includes the cities of Kent, Auburn, Renton, Tukwila, and parts of Sumner in Pierce County).

Exhibit 1
Manufacturing Locations of Companies Interviewed



Source: Stakeholder Interviews 2006

- Freight-intensive operations (industrial and warehouse) development is growing further to the south, with most of the growth occurring from Tacoma south to Lewis County.
- Trucks are the most relied-upon mode for local and regional shipping needs.
- Freight-intensive operations (industrial and warehouse) development is growing further to the south, with most of the growth occurring from Tacoma south to Lewis County.
- Trucks are the most relied-upon mode for local and regional shipping needs.
- Every company in the Puget Sound Region is dependent on the same highway network, with several sections being relied on by almost every industry.
    - I-5 from Everett in the north to Lewis County in the south
    - I-405 through Bellevue
    - SR 167 – at the I-405 interchange and at the I-5 & Port of Tacoma interchange
    - I-90 over Snoqualmie Pass
- Businesses have had to adapt to local congestion in similar ways:
    - Adding satellite distribution locations to shorten trips in the region.
    - Investing in additional trucks and hiring additional drivers to deliver proportionately less volume. One company indicated that their transportation fleet has doubled in the last few years, despite volume growth of only 20 percent.
    - Investing in new technologies, routing, GPS, mapping and/or communication devices to counteract traffic-related issues and delays.
    - Adding inventory to compensate for unreliable transportation system. Five of the businesses interviewed have increased inventories by 5 to 20 percent to compensate for transportation inefficiencies.
    - Making operational changes, such as extending operating hours, paying overtime, using alternative delivery modes, staging delivery vehicles at driver/employee homes, pre-palletizing/consolidation of loads to reduce driver dwell time, early carrier arrival to ensure on-time pick-up/delivery, pre-staging/pre-loading trucks, and redundant scheduling.
    - Accessing the WSDOT traffic web site to assist in routing trucks.
- There is little to no redundancy in the primary regional freight corridors.
- There is a constant shortage of qualified truck drivers in the Puget Sound region.
- It is difficult to access local ports due to congestion at the port gates.
- Growth in the urban areas has resulted in increased parking restrictions and reduction of truck staging and maneuvering facilities.
- Certain policy issues inhibit and negatively affect freight movements: flatbed trucks cannot use HOV lanes, noise restrictions prevent extending delivery times to many construction sites, restrictions and permit requirements imposed by the City of Seattle limit construction traffic to off-peak hours, and design standards for trucking corridors vary widely between governmental agencies.

Recommended Actions

The conclusions of this report are meant to help direct freight finance and planning decisions during future Washington State Department of Transportation strategic plans. To this end, it was deemed most useful to divide recommendations into two categories, "Priority" and "Other." Within these two categories, they are further divided into operational improvements, capital improvements, and policy recommendations.

PRIORITY ACTIONS

The manufacturing industry in the Central Puget Sound region would benefit most from the following high priority actions to improve freight movement. These recommendations are based on the findings of the targeted industry surveys and the technical expertise of the consulting team. The projects are directed at improving mobility for the industrial and manufacturing businesses located within the Central Puget Sound region. Two of the actions listed below are operational measures that can be implemented in the short-term. The others are longer-term capital improvements.

1. Expand WSDOT's Web-based traffic flow map to provide better traffic flow information and camera coverage in the urban area as well as to expand the network beyond the current limits. Some of these locations are already in the capital budget, including:
   - I-5 between Federal Way and Tacoma
   - SR 516 between I-5 and SR 167

   Other locations are recommended, including:
   - I-5 south to Lewis County (and perhaps through Centralia)
   - I-5 north of Everett through Skagit County (includes remaining two-lane section in Mount Vernon in preparation for additional congestion that could occur in 2010 for the Vancouver Olympics)
   - SR 167 south of Auburn
   - I-90 between Issaquah and North Bend
   - SR 18 (adding cameras)
   - SR 169 near I-405

2. Increase incident response along major freight corridors, and expand hours to include midday. Major corridors include:
   - I-5 from Seattle to Lakewood
   - SR 167 from Renton to Puyallup
   - SR 599 from 1st Avenue S. Bridge to I-5
   - I-90 from Seattle to Issaquah

   Some of these are already in the capital budget, including:
   - Funding for one additional patrol in the south end of I-405 during peak traffic congestion (including the SR 167 interchange)
   - Funding for two additional patrols during peak traffic congestion on Highway 18 and in south King County

3. Complete missing links on major freight routes to improve connectivity and reliability for freight. The highest priority freight routes to improve the reliability for Central Puget Sound manufacturing are:
   - SR 167 from I-5 to SR 161, with a direct connection between SR 167 and I-5. The extension was proposed to be funded in past iterations of the Regional Transportation Investment District (RTID); however, the interchange with I-5 was not funded. In order for this project to serve regional freight needs between the

customers and manufacturing centers, a connection between I-5 and SR 167 is needed.

- SR 509 from S. 188th Street to I-5. This project was proposed to be funded in past iterations of the RTID. This project will benefit freight by creating a parallel route to I-5 that connects from Seattle's Duwamish Industrial Area to the Kent Valley. In addition to relieving congestion on this critical section of I-5, the SR 509 project will also provide an alternate route to improve the reliability of the entire system.

4. Increase capacity along major freight routes. These include:
    - I-5 from Mercer Street to the Boeing Access Road. Capacity increases may be possible by improving the ramp weave-merge section between the West Seattle Freeway and I-90 and by reconfiguring ramp access to and from downtown Seattle. There is no concept or funding for potential improvements in this section.
    - SR 167 from I-405 to Sumner. HOV and ramp improvements are proposed as part of the SR 167 Corridor project. Partial funding for this project has been provided by the "Nickel Account," with the remaining funds proposed in past iterations of the RTID.

OTHER FREIGHT PROJECTS

There are many other projects that would enhance freight mobility for industrial and manufacturing businesses in the State of Washington. The list below is also based on the targeted industrial sector surveys. These are listed below by type of project: Operational, Infrastructure, and Policy.

Operational

1. Reduce disincentives to delivering at night (from 7:00 P.M. to 7:00 A.M.) to relieve daytime congestion on the roadways and improve efficiency of delivery.

2. Consider incentive programs, such as PierPass in Los Angeles/Long Beach, that would shift Port truck traffic to nighttime hours.

3. Allow trucks to bypass ramp meters at locations with high truck volumes and steep grades or short merge lengths.

Infrastructure

4. Replace failing infrastructure that, if lost, would dramatically affect capacity on the major freight routes of I-5 and I-405. This includes replacing the Alaskan Way Viaduct and SR 520 Bridge. Funding for these projects is expected to be from a mix of local, state, and federal funding options.

5. Improve I-90 to reduce weather-related closures and increase capacity over Snoqualmie Summit. This project has been funded out of the 2005 Transportation Partnership Account.

6. Complete planned major truck linkages to the Port of Seattle and Port of Tacoma. Specific projects include:
    - SR 519 Phase 2
    - Spokane Street Viaduct Project (widening and ramp improvements are currently unfunded)
    - East Marginal Way Grade-Separation Project (funded)
    - Lincoln Avenue Grade-Separation Project (partially funded, currently in design)
    - Port of Tacoma Road Interchange Improvements (being considered as part of I-5 mainline improvements through Fife.)
7. Increase capacity on I-5 from Fife to Fort Lewis. A portion of the project—from Port of Tacoma Road to Pacific Avenue in Tacoma—is proposed as part of an "Add HOV Lanes" project, which received partial funding from the 2005 Transportation Partnership Account and was fully funded in past iterations of the RTID proposal. A separate project being constructed as part of the I-5/SR 16 interchange improvements would extend the HOV lanes to SR 16. An extension further south is not yet funded.

8. If additional HOT lane or other managed lane programs are implemented, infrastructure improvements such as direct access ramps that would improve truck access into the lanes should be considered.

Policy

9. Establish state-wide standards for regional trucking corridors (e.g., lane widths, turning radii, etc.) and prevent local municipalities from superseding state-defined standards.

10. Create a direct funding stream for improvements to arterial truck routes that provide access to I-5, I-405, SR 167, SR 99, and SR 18. This funding mechanism could use the existing State's Freight and Goods Transportation System (FGTS) Classifications for "T-1" and "T-2" routes.

11. Update FGTS route maps on an annual basis. Ensure continuity in the route classifications between jurisdictions. Updates could be performed as part of regional Metropolitan Planning Organization (MPO) 10-year planning processes. These maps are currently updated every two years by the state, but could benefit from a yearly update.

12. Consider reducing tolls (e.g., on Tacoma Narrows Bridge) for trucks that move at night.

13. Increase driver training programs. Work with Homeland Security to increase the pool of drivers eligible to move restricted commodities.

14. Consider programs that would reduce cost to individual driver-owners, such as insurance pools and shared maintenance programs.

The results of this study confirm that the highway network is essential to businesses in this state since the vast majority of goods are moved by truck. Improvements that benefit truck movements will help the Washington State economy.

SECTION 2
OVERVIEW OF TARGET SUPPLY CHAIN SECTORS

INTRODUCTION

This section of the report summarizes the three manufacturing sectors in the Central Puget Sound region whose supply chains are evaluated as part of this study. It introduces the three industries, documents their role in the regional and state economies, and suggests how this information guided the following stages of this study.

SELECTION OF STUDY INDUSTRIES

Since Washington has a rich diversity of industries that generate freight demand, it is important to focus on the dynamics for specific industries that are important to the regional and state economy. Therefore, this study targets three key supply chain segments that offer the best insight into the freight competitiveness and efficiencies of the manufacturing in the Central Puget Sound area.

The selection of these target industries was guided by several factors, including previous studies such as the *Washington Transportation Plan Update: Freight Report 2005* (WTP)[1], consultation with a freight advisory committee, an economic comparison of industries within the Central Puget Sound, and discussions with regional freight experts. The three industries selected for further analysis in this report are:

1) Building and construction
2) Processed Food
3) Aerospace

The following are descriptions of each of the industry sectors.

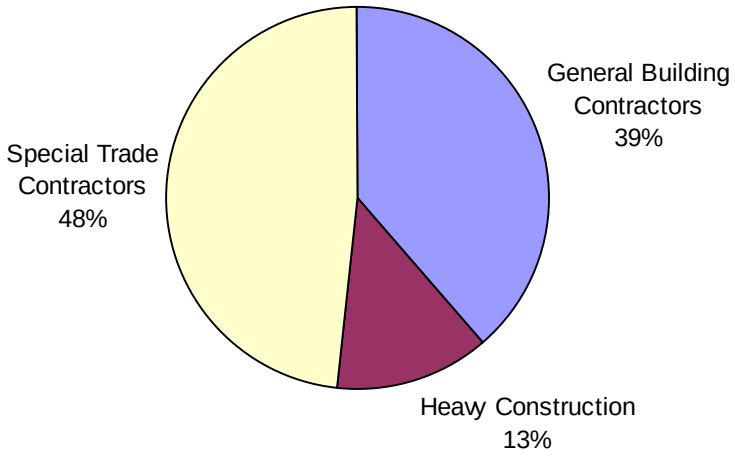
BUILDING AND CONSTRUCTION INDUSTRY

Production Output Value

The building and construction industry is a major industry in Washington State and the Central Puget Sound region. In 2004, statewide construction gross business revenues were roughly $30 billion.[2] As shown in Exhibit 2, these revenues were almost half (48 percent) from special trade contractors (including plumbers and electrical contractors), 39 percent from general building contractors, and 13 percent from heavy construction. A total of $843 million in wood products for construction were exported in 2004, the state's fourth greatest export by value.[3]

[1] http://www.wsdot.wa.gov/freight/images/WTP_FreightUpdate.pdf
[2] Washington State Department of Revenue. *Quarterly Business Review Calendar Year, 2004. Table 1: Total Gross Business Income Statewide by Industry (SIC)*
[3] Washington State Office of Trade and Economic Development

Exhibit 2
Gross Income Composition by Key Building and Construction Sector (Statewide): 2004[4]



Employment

A combined 88,410 people were employed in the building and construction industry in the Central Puget Sound area in 2004,[5] a number that represents 5.7 percent of total regional employment. Of these, 56,075 were employed as specialty contractors, 22,269 were employed as general contractors, and 10,066 as heavy construction workers. This accounts for some $2.2 billion dollars in wages generated in the Central Puget Sound region alone; $1.6 billion of this was generated by special trade contractors. These estimates do not include employment in the secondary and tertiary industries supported by the construction and building industry.

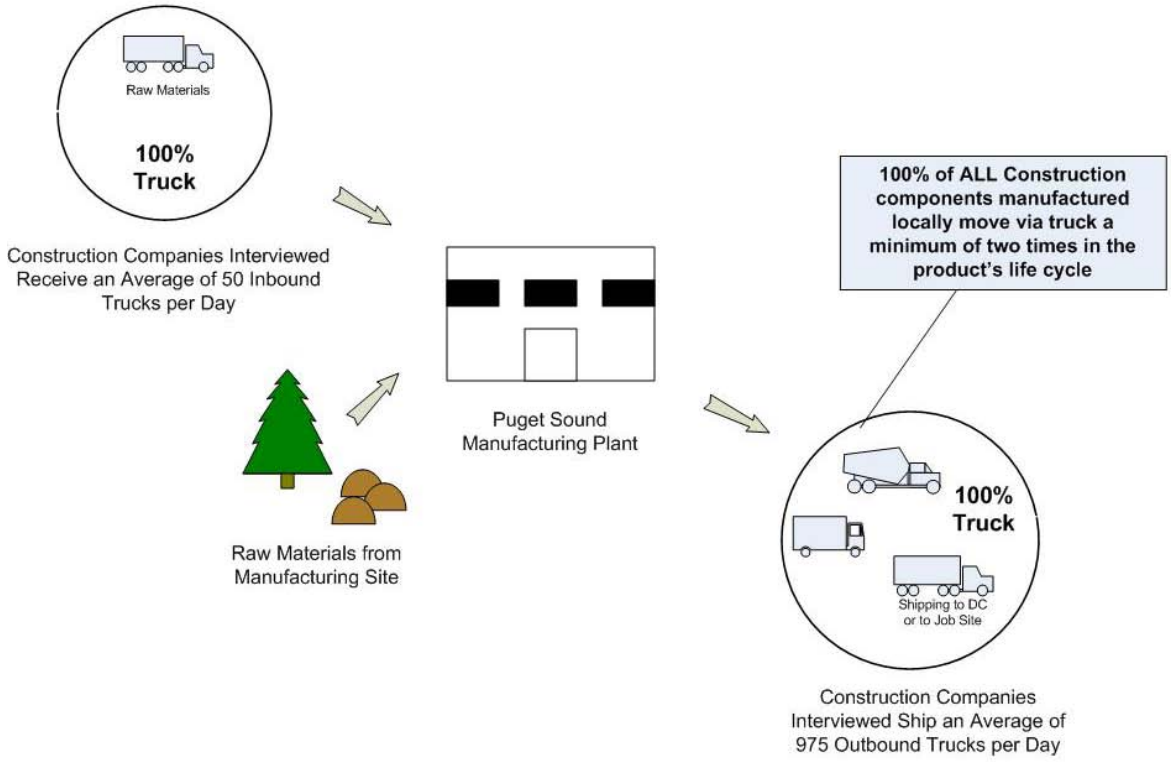
Summary of the Typical Building and Construction Industry Supply Chain Structure

Most of the construction industry firms surveyed for this study manage or support the construction of large single-family residential housing developments. It included The Quadrant Corporation, along with secondary suppliers for lumber, furnace, and concrete.

Exhibit 3 shows a typical supply chain for a construction-related manufacturing business. Raw materials, such as sand, gravel, or trees, are mined or harvested at mostly rural sites, trucked to a manufacturing facility (mill or plant) and processed with materials such as fly ash or additives which also arrive via truck. After manufacturing or value-added processing, 100 percent of goods are shipped via truck to a distribution facility or construction site.

[4] Washington State Department of Revenue. *Quarterly Business Review Calendar Year, 2004. Table 1: Total Gross Business Income Statewide by Industry (SIC)*
[5] Workforce Explorer, Washington: http://www.workforceexplorer.com/

EXHIBIT 3
SUPPLY CHAIN FLOW DIAGRAM: CONSTRUCTION INDUSTRY



The average number of receipts and shipments per day reflects data provided by the companies interviewed. Concrete is actually the most time-sensitive product shipped by any company that was part of this study, with a useful shelf life of approximately 90 minutes. Traffic congestion and the associated delay can cause an entire load of product to be rendered unusable.

Secondary and Tertiary Suppliers

The Central Puget Sound area, like many growing urban areas, has developed a flourishing construction industry. This can be attributed to factors such as the strong local demand and well-developed local supply of raw materials and manufactured products. The building industry represents supply chains that are domestically and regionally focused, primarily based on the relative abundance of rich natural resources in the Pacific Northwest. This sector provides insight into a supply chain structure that is locally and regionally based. Secondary and tertiary industries have evolved to supply the building and construction industry, including suppliers of concrete, asphalt, wood, and steel. Examples of these secondary and tertiary suppliers are shown in Exhibit 4.

EXHIBIT 4
SAMPLE LISTING OF BUILDING AND CONSTRUCTION INDUSTRY SECONDARY AND TERTIARY SUPPLIERS

Secondary Industries	Products	Tertiary Industries	Products
Window suppliers	Windows, doors, other glass structures	Raw material providers	Glass, special glass
Asphalt	Hot asphaltic concrete materials, including paving, crack sealing, and resurfacing products	Raw material providers	Crude oils, recycled asphalt
Finished wood	Walls, floors, other wooden construction	Raw material providers	Lumber
Cement	Foundations, retaining walls, revetments	Raw material providers	Sand, gravel, crushed stone
Steel products	Structural elements, including platforms, pipes, etc.	Raw material providers	Steel
Electrical systems	Lighting systems and remodeling	Raw material providers	Electrical switches, wiring

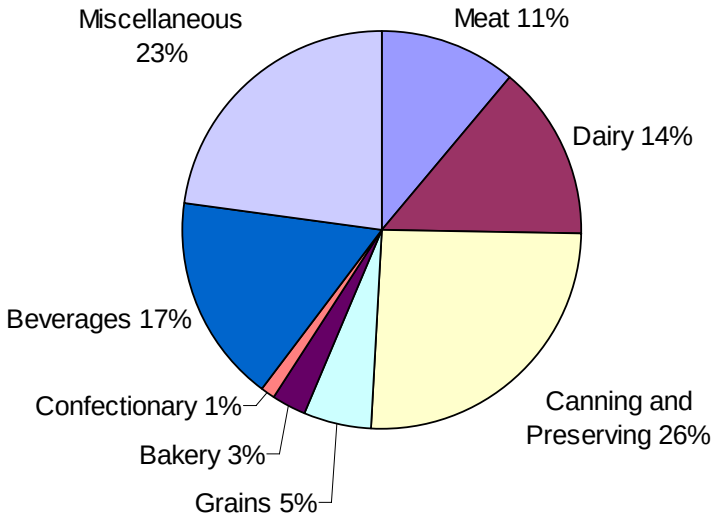
THE PROCESSED FOOD INDUSTRY

Production Output Value

Washington State's food processing sector is the second largest manufacturing industry in the state. Major processed foods exported from Washington State include dairy products, seafood, and bottled beverages. Together, processed foods account for about 11 percent of the total value of the manufacturing output in Washington State, with almost $12 billion in annual revenues in 2004[6]. Exhibit 5 shows the gross business income of the major food processing categories in the state, with canning and preserving, beverages, dairy, and meat as the largest categories at 26 percent, 17 percent, 14 percent, and 11 percent of the respective total gross income share.

[6] Washington State Department of Revenue. *Quarterly Business Review Calendar Year, 2004. Table 1: Total Gross Business Income Statewide by Industry (SIC)*

EXHIBIT 5
PROCESSED FOOD STATEWIDE GROSS INCOME COMPOSITION: 2004[7]



Employment

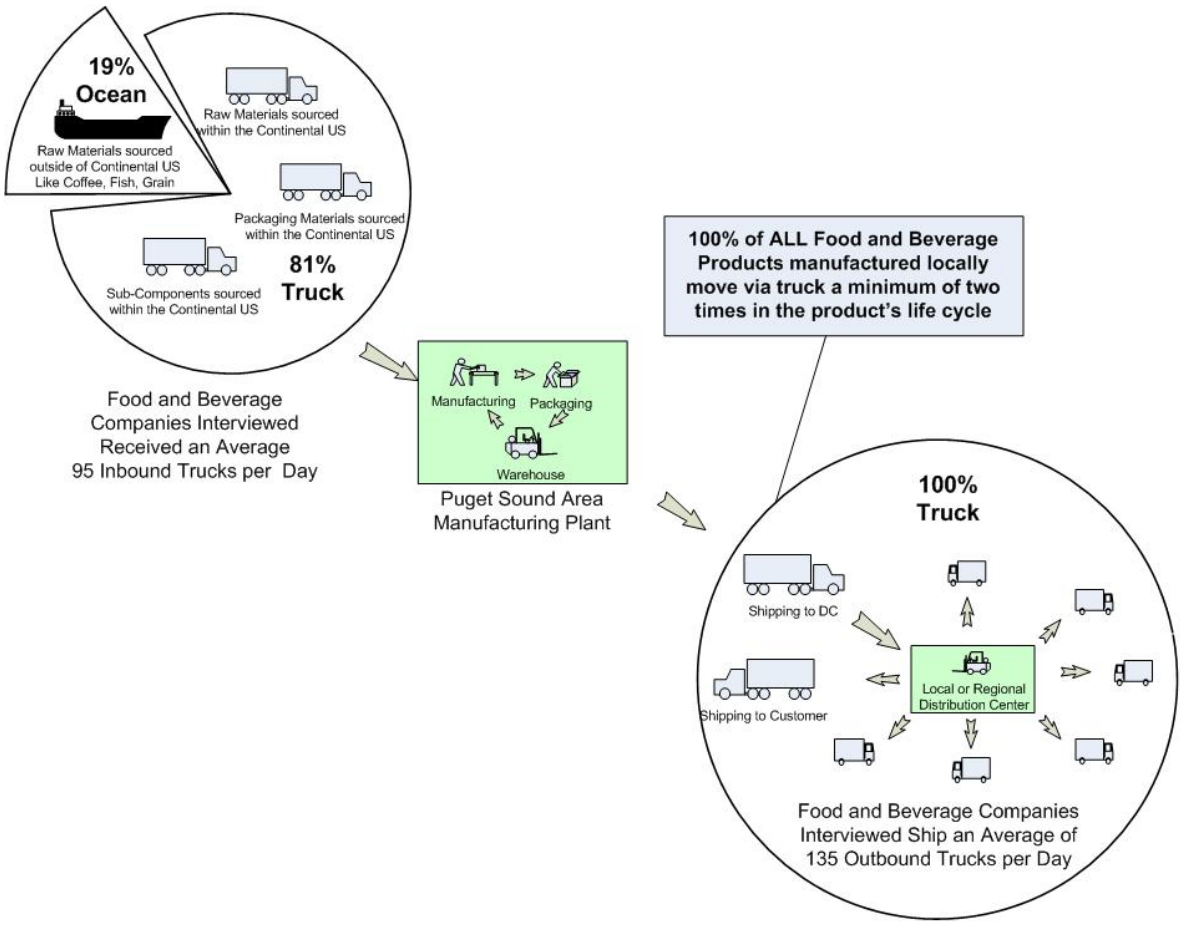
An estimated 40,000 workers[8] are involved in the cleaning, preparation, sterilization, and packaging of beverages and food in Washington State, representing 1.5 percent of all people employed in the state.[9] In the Central Puget Sound region, about 16,000 people are employed in the manufacturing of food and beverages, with a total wage income of about $680 million dollars.[10] These numbers do not include employees working in secondary and tertiary industries that support the processed food industry.

Summary of the Typical Processed Food Supply Chain Structure

Exhibit 6 depicts a typical supply chain in the food and beverage manufacturing industry, as developed from data provided by companies interviewed as part of this study. Food and beverage companies in the Puget Sound region source their materials from local, national, and international suppliers. Most of the goods manufactured in the area are shipped to local destinations, but significant shipments to national and international customers occur on a daily basis.

[7] Washington State Department of Revenue. *Quarterly Business Review Calendar Year, 2004. Table 1: Total Gross Business Income Statewide by Industry (SIC)*
[8] http://www.cityofseattle.net/tda/industry/agriculture.htm
[9] http://stats.bls.gov/eag/eag.wa.htm
[10] http://workforceemployer.com

EXHIBIT 6
SUPPLY CHAIN FLOW DIAGRAM: FOOD INDUSTRY



Items arriving via ocean freight are almost exclusively raw materials, such as coffee, seafood, or grain, sourced from other countries. The majority of the remaining inbound materials are for packaging and come from the immediate area or from within the contiguous United States. This type of inbound freight predominantly moves by truck. Other items arriving by truck include raw materials such as flour, fresh/frozen meat products, sweeteners, syrups, flour, and baking ingredients. Packaging and ingredients are sourced globally, processed and packaged, then distributed to predominantly local markets. Over 85 percent of outbound volume is delivered to customers within the Pacific Northwest.

Secondary and Tertiary Suppliers

The processed food sector provides insight into a supply chain structure that is more regionally and nationally focused, due primarily to the perishable nature of the products. Secondary suppliers to the processed food industry include companies involved in conveying, filling, sealing, cutting, sterilizing, and packaging. They also include companies that supply the raw foods that go into the processed foods, including grains, sugars, meats, etc. Tertiary suppliers

typically produce the materials used by the secondary suppliers, including things such as plastics, metals, glass, refrigeration devices, etc. A sample of the secondary and tertiary suppliers to the processed food industry are listed in Exhibit 7.

EXHIBIT 7
PROCESSED FOOD INDUSTRY SECONDARY AND TERTIARY SUPPLIERS

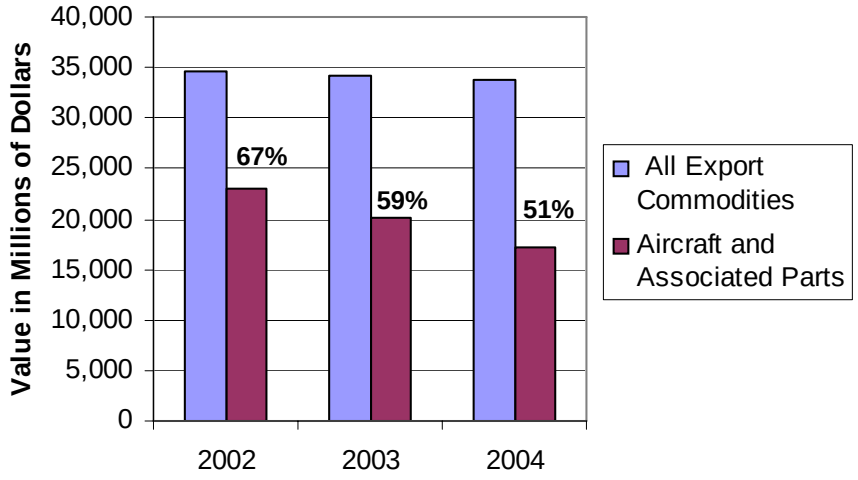
Secondary Industries	Products	Tertiary Industries	Products
Conveyer manufacturers	Conveyer belts	Raw material providers	Plastics, textiles, metals, cables, other conveyer belt raw materials.
Refrigeration and freezer components	Linear freezers, flat product freezers, flash coolers, IQF freezers, cooler equipment, and spiral freezers	Raw material providers	Metals, glass, plastics, refrigeration devices and parts
Sterilizers	Rotary pressure sterilizers, hydrostatics, small lab sterilizers, high capacity batch retort systems	Raw material providers	Metals, plastics, rubber sealants
Dry material handlers	Bin dumpers, mixers, bins, blenders, tanks, vibrating weigh-filling systems	Raw material providers	Motors, plastics, metals
Fillers	Fill & seal machines, liquid filling machines	Raw material providers	Metals, plastics, rubber sealants, etc.
Cutters	Cutting/size-reduction machines, portion control equipment, presses, ultrasonic cutting	Raw material providers	Blades, metals, plastics, etc.
Closers	Can sealers, closing machines, fill & seal machines	Raw material providers	Metals, plastics, rubber sealants, etc.
Raw food suppliers	Agricultural products, liquids, sugars and other raw foods	Raw material providers	Metals, plastics, rubber sealants, etc.

AEROSPACE INDUSTRY

Production Output Value

The aerospace sector is the largest manufacturing industry in Washington State. Combined sales of aircraft and associated parts accounted for over 24 percent of the total value of the manufactured output in Washington State, with almost $25 billion in annual revenues in 2004.[11] It is also the state's leading export industry. As shown in Exhibit 8, the industry has been responsible for at least 51 percent of the state's total export value for at least the past three years.[12]

EXHIBIT 8
AEROSPACE INDUSTRY'S ROLE IN WASHINGTON'S EXPORTS



Employment

In 2003, the industry employed approximately 70,000 people in the region, with total wages of almost $5 billion dollars.[13] Current estimates predict that the number employed in aerospace will increase over the next few years, up to approximately 75,000–78,000 in 2006.[14] These numbers do not include people working in the secondary or tertiary supply industries.

Summary of the Typical Aerospace Supply Chain Structure

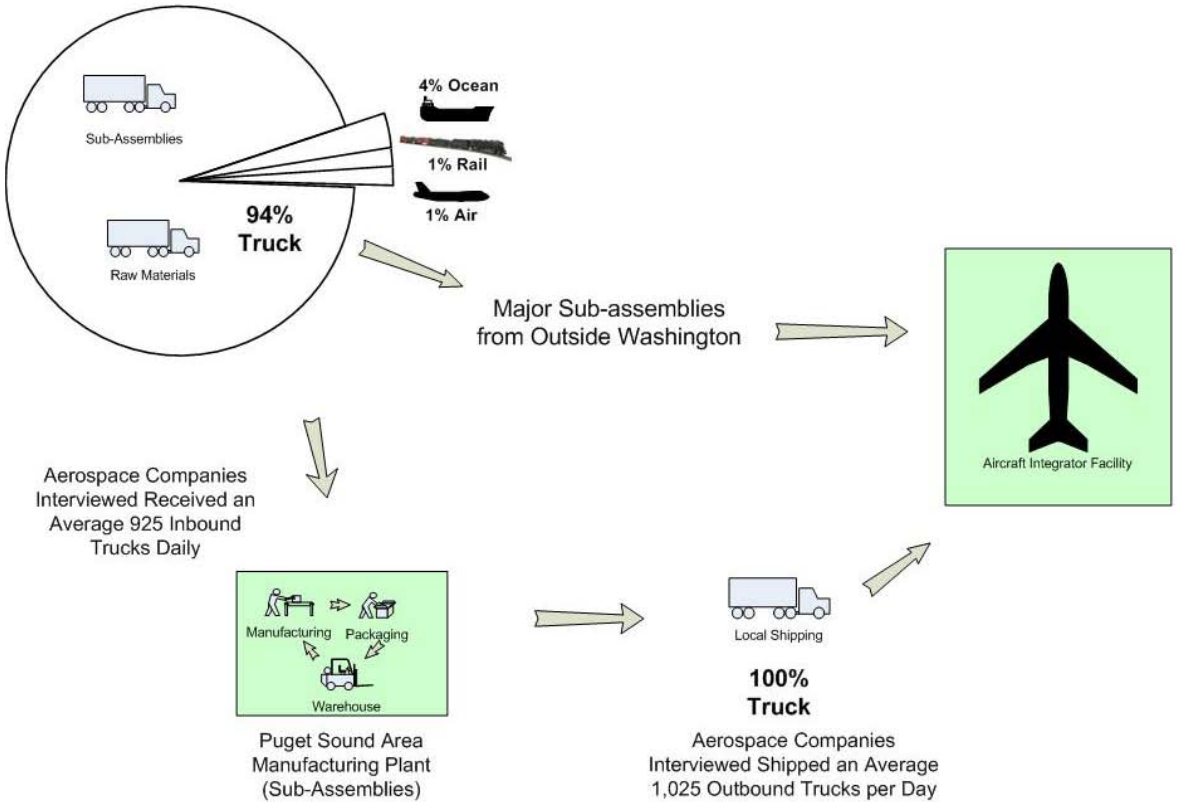
For this report, the aerospace industry was confined to the manufacture and repair of commercial aircraft. This included Boeing, the major aerospace manufacturing company in the

[11] Washington State Department of Revenue. *Quarterly Business Review Calendar Year, 2004. Table 1: Total Gross Business Income Statewide by Industry (SIC)*
[12] Washington State Office of Trade and Economic Development, http://www.cted.wa.gov
[13] http://www.workforceexplorer.com
[14] *Aerospace: Cyclical Comeback with Hopes to Slow Structural Declining.* Alex Roubinchtein. Retrieved from http://www.workforceexplorer.com/article.asp

Central Puget Sound region, as well as secondary and tertiary suppliers to Boeing, including TMX (aluminum and sheet metals) and Goodrich (cargo restraint and conveyance products).

The aerospace industry has the most complex and far-reaching supply chain of the three studied in this report, as depicted in Exhibit 9. As a key industry in the State of Washington, the aerospace industry involves both local companies that manufacture parts and sub-assemblies for the aircraft integrator, as well as the aircraft integrator itself.

EXHIBIT 9
SUPPLY CHAIN FLOW DIAGRAM: AEROSPACE INDUSTRY COMMERCIAL AIRCRAFT PRODUCTION



Sub-assembly component manufacturers interviewed receive an average of 925 inbound trucks daily. Sub-assemblies manufactured outside the region (i.e., fuselages, engines) are shipped directly to the aircraft integrator facility. The majority of raw materials in and out of regional sub-assemblies arrive via truck. Puget Sound region sub-assembly manufacturers ship an average of 1,025 trucks each day to the aircraft integrator facility. All finished product (a completed plane) is flown from the integrator facility to the customer.

As many components used in the assembly of aircraft are now manufactured outside the state, and even outside the United States, the amount of time it takes to move an item to or from a local manufacturer to Boeing using local highways or surface roads is less significant than for other industries with a more local focus. As a component of Total Delivered Cost (TDC) (a concept that will be explained further in Section 4 of this report), freight is a minor component of the cost of a multi-million dollar aircraft. Still, the sheer volume of trucks used to move goods in the area in support of local manufacturing operations is significant.

Secondary and Tertiary Suppliers

The aerospace industry has a very complex system of suppliers, as is typical for most large manufacturers with an extensive global supplier base. Therefore, the aerospace sector is a good proxy for evaluating the efficiencies and competitiveness of a global manufacturing supply chain structure. Exhibit 10 lists a sampling of secondary and tertiary suppliers that are likely to work in the Central Puget Sound's aerospace industry. Secondary suppliers to the aerospace industry include companies involved in engineering, technology, manufacturing, and systems integration. Tertiary suppliers typically produce the materials used by the secondary suppliers, including finished metals, electronic wiring, and other raw materials.

Exhibit 10
Aerospace Industry Secondary and Tertiary Suppliers (Sample)

Secondary Industries	Products	Tertiary Industries	Products
Aircraft component manufacturers	Window frames, wing spars, engine pylon assemblies, bulkheads, airframe structural components, landing gear, tail skid assemblies, Access doors, etc.	Raw material providers	Glass, metals, plastics, rubber
Specialized metal manufacturers	APU bellows, insulation blankets, ECS ducts, starter ducts, vapor seals, anti-ice rings, stainless steel rings	Raw material providers	High temperature and high-strength steel and other specialized metals
Hydraulic systems engineering specialists	Hydraulic power generating systems and associated pumps, motor pumps, and couplings	Raw material providers	Metals, glass, circuits
Electrical and mechanical systems	Electronic controls, crew information systems, data management systems, flight control systems, navigation and supply systems	Raw material providers	Electronic components
Mechanical systems providers	Engine systems, landing gear and door actuation, propellers, electromechanical actuation	Raw material providers	Plastics, metals, rubber
Engine components	Rotating and static engine components	Raw material providers	Metals, individual engine components

Summary

These three industries, the aerospace industry, the processed food industry, and the building and construction industry, serve as case studies for further analysis of manufacturing supply chains in the Central Puget Sound region. All three industries are of great regional prominence, and all have tremendous impacts on the regional and state economic activity.

Section 3
Issues, Constraints, and Potential Remedies Based on Freight Interviews

Introduction

The purpose of this section is to summarize the information gathered through the interview process. The survey was conducted as an effort to better understand the freight supply chain and transportation issues faced by the three sectors targeted for this study:

1. Building and Construction
2. Processed Food
3. Aerospace

A copy of this survey document is included as Appendix A. The survey was developed in order to identify and quantify bottlenecks and deficiencies in the existing transportation system that affect the respective supply chains.

This section is organized around the following topics:

1. **Profile of Businesses, Industry Sectors, and Supply Chain Types:** Describes the industries that were included for this study and groups them into supply chain types.

2. **Industry Coping Strategies and Supply Chain Innovations:** Describes how the surveyed companies have adapted to cope with the negative effects of traffic congestion in the region.

3. **Transportation Issues:** Summarizes specific operational, infrastructure, and policy issues that emerged during the interviews.

4. **Response to Transportation Investment:** Presents a methodology for determining how businesses in Washington may respond to investments in the transportation system.

5. **Potential Solutions:** Summarizes ideas for potential solutions raised by interviewed businesses.

Profile of Businesses, Industrial Sectors, and Supply Chain Types

Representatives from thirteen companies in the three targeted sectors, along with one freight hauling firm, were surveyed in person for this study. Several follow-up surveys by telephone were also performed to finalize the surveys. Individual company interviews are summarized and presented in Appendix C. Representatives from the following businesses, along with Carlile Transportation Systems, were interviewed:

Aerospace Industry
- Boeing Corporation
- Goodrich Aircraft Technical Services
- Goodrich Cargo Group
- TMX Aerospace

Processed Foods Industry
- US Bakery (Franz)
- Trident Seafoods
- Starbucks Coffee Company
- A processed food company
- An international beverage company

Building/Construction Industry
- Quadrant Corporation
- Cadman, Inc.
- Woodinville Lumber
- Bob's New Construction

The companies analyzed in this study range from those that are locally owned and operated to those that are national or global in scope. Without regard to company size, the analysis focused on the inbound and outbound transportation requirements within the Puget Sound region. In the case of national or global companies, the decision was made to focus solely on the operations of the facility or plant located within the Puget Sound region. This approach allowed for a more full assessment of the relationships between the freight delivery system of each industry and the transportation facilities within WSDOT's purview.

The following criteria were developed to classify the industries into categories for further analysis. All results are summarized in a table titled "Supply Chain Summary" in Appendix B.

MARKET AREA

This refers to the geographic area where the goods and services of each company are distributed or sold. The market area was divided into three broad categories:

- **Local:** Includes the Puget Sound region.
- **Regional/National:** Includes other states and regions within the United States and Canada.
- **Global/International:** Includes locations anywhere in the world.

DEPENDENCE ON TRANSPORTATION NETWORK

This explains the emphasis on a local, regional, or global transportation system as it relates to the freight movement of each company. As before, this classification focuses on the local plant or facility of each company, and does not extrapolate to the national or international facilities of any company.

- **Local:** Includes the transportation system that services only the Puget Sound region.
- **Regional/National:** Includes the transportation system that services areas beyond the local Puget Sound region, including other northwestern states and western Canadian provinces.
- **Global/International:** Includes the transportation system that services locations anywhere in the world.

OTHER FACTORS

Several other characteristics of each company's supply chain were examined as part of this analysis:

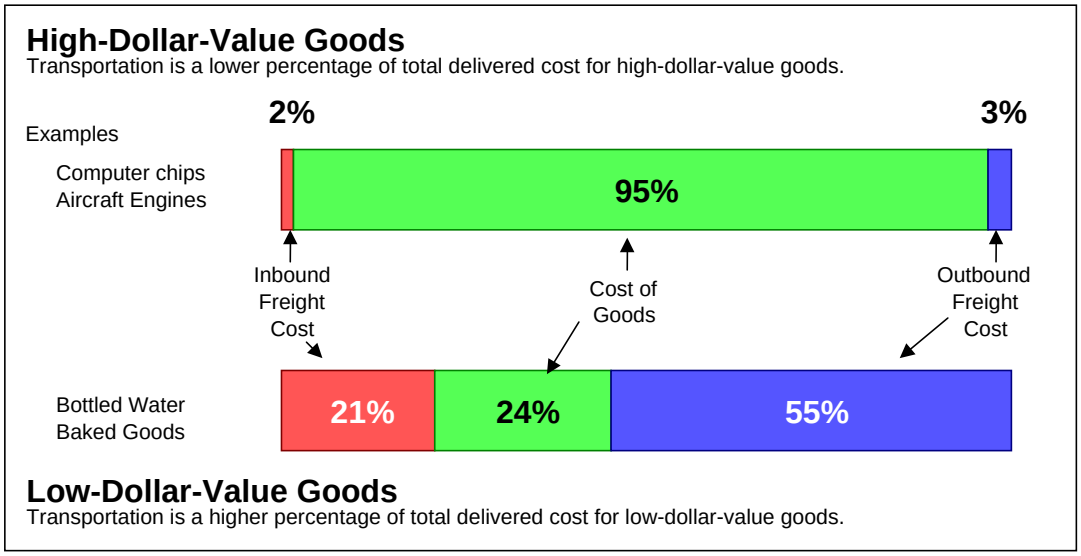
- **Complexity:** Within the scope of this study, no causal relationship was identified between the complexity of a company's supply chain and its dependence on the Puget Sound transportation infrastructure. Further, the size or reach (local market vs. global market) had no bearing on the complexity or sophistication of the company's handling of freight.

- **Number of Truck Trips per Week:** Reliance on trucks was the common supply chain denominator across all industries studied. The majority of goods entering the Puget Sound region will travel by truck at least twice during the product life cycle. Therefore, part of the criteria included an estimate of the average number of truck trips generated by each company in a typical week. The number included both inbound and outbound shipments. The companies interviewed generate an estimated 19,000 truck trips per week, or an average of 3,000–4,000 truck trips per business day. Truck movements include the following:
    - Vendor or supplier to plant or distribution center
    - Port or docks to plant or distribution center
    - Airport to plant or distribution center
    - Plant to distribution center
    - Plant to customer
    - Distribution center to customer

- **Travel Mode:** This category indicates all modes of travel the company uses in its supply chain, including truck, rail, ocean, and air.

- **Cost of Goods:** Business behavior is driven by business income. The study found that when Central Puget Sound manufacturing companies manufacture low-cost products (e.g., bread), high transportation costs can severely affect net business income. For high-cost products, transportation costs represent a lower proportion of the total cost of goods. This relationship is shown in Exhibit 11.

EXHIBIT 11
RELATIVE IMPORTANCE OF TRANSPORTATION COSTS



INDUSTRY COPING STRATEGIES AND SUPPLY CHAIN INNOVATIONS

The interviews revealed many common themes among the businesses surveyed, including how they cope with transportation issues. The overarching themes that emerged are summarized below.

SUPPLY CHAIN FOCUS AND LOCAL CONGESTION

While the issue of local traffic congestion came up regularly, the relative importance, attention, and urgency accorded to it varied across the surveyed companies. The businesses that have locally focused supply chains have the largest reliance on the local highway network. For them, nearly 100 percent of their material inputs and finished products are received and distributed by trucks in the Puget Sound region. Therefore, local traffic congestion rose to the top as a dominant issue affecting the reliability, cost, efficiency, and productivity of their supply chain. For example, the Woodinville Lumber yard serves as the main facility for all of Woodinville Lumber's receiving, repackaging, and re-distribution of lumber. Lumber arrives, by truck, from mills all over the Pacific Northwest and Canada. It is then repackaged in the Woodinville facility, loaded onto another truck, and taken to local job sites. Congestion and load-limit

restrictions on local highways affect all inbound and outbound movements for these more locally-based supply chains.

Another company reported that in 2001, a round trip from Bellevue to Tacoma took an average of 90 minutes; at the time of the survey (2005) it was common for the same trip to take between 120 to 150 minutes. Businesses that move most of their products within the local region are more affected by these increases in local congestion than businesses that use local highways for just a portion of a long-distance trip. Companies compensate for the additional congestion by paying drivers overtime, purchasing additional trucks, and hiring more drivers. All of these compensation measures add substantially to the cost of doing business in the Puget Sound region.

Even businesses with global supply chains such as Boeing can be challenged by local congestion. There is a difference in how local congestion is viewed by Boeing, specifically as it relates to the parts of the supply chain it directly controls, and the parts of the supply chain that are controlled by its global system of suppliers. Although Boeing has a global reach and transportation requirements, the aspects of the business it directly manages rely almost entirely on the local infrastructure system. As an integrator, Boeing depends on a large group of suppliers to supply raw materials and component parts for aircraft assembly. Large multinational firms manufacture, fabricate, and assemble large component parts (for example the whole engine, the entire landing gear, etc.), and Boeing assembles the final aircraft. The bulk of the activities directly controlled by Boeing are local, from manufacturing to fabrication to assembly. Moreover, as a rule, Boeing assumes control of the bulk of the locally based transport of parts, even providing local transport service for its suppliers. Therefore, the share of supply trips it directly controls is predominantly local, making transportation systems a key priority.

ADAPTATIONS TO COPE WITH LOCAL CONGESTION

All businesses interviewed have had to make changes to increase transportation efficiencies. All of these changes add costs for the businesses. Ranked according to the relative cost of implementation, one or more of the following coping strategies have been adopted by the surveyed businesses:

1. **Investment in warehouses or satellite facilities:** Firms have added satellite distribution locations to serve the same geographic area previously served by one facility. This response is most evident among carriers that provide trucking services. Carriers that are located south of Seattle, towards Tacoma, are finding it more difficult to provide reliable same-day service to customers located to the north of Seattle, and on the east side. Some carriers are supplementing ground service with air shuttle services (such as DHL or FedEx) to improve service and reliability. At least two businesses interviewed invested in or expect to invest in additional facilities to compensate for traffic congestion and the growing migration to the south of manufacturing/distribution facilities.

2. **Increasing the size/capacity of the truck fleet**: Five companies indicated that congestion and Puget Sound infrastructure issues are the main reasons for investing in additional trucks and hiring additional drivers to deliver proportionately fewer goods. Several companies cited examples of typical transit times doubling between the north

and south ends of the Puget Sound in the past five years. One company indicated that their transportation fleet has *doubled* in the last few years, despite volume growth of only 20 percent. Another business indicated that it requires 30 percent more equipment and drivers to compensate for area congestion. This business estimates the additional cost of this labor and equipment at $300,000 per year. Similarly, the international beverage company interviewed estimates that transportation efficiency is declining at a rate of 15 percent to 20 percent annually. It expects to pay more overtime and add additional trucks and drivers to compensate. Bob's New Construction invested in larger trucks to facilitate making larger drops to a construction site, thereby reducing total trips. Another business dedicated two vehicles and drivers to handle critical delivery requests.

3. **IT/communication investments**: Five companies indicated they invested in routing, GPS, mapping, and/or communication devices to counteract traffic-related issues and delays. Bob's New Construction has installed communication devices on all trucks to assist in communicating traffic-related issues. Bob's has also installed GPS devices in its fleet to track movement and measure dwell time. U.S. Bakery has invested in route optimization software as well as GPS systems. They continually review the WSDOT traffic website and communicate with drivers to reroute trucks around traffic issues. Communication devices are commonly used to increase communication among drivers and dispatchers to alert others to congestion along routes.

4. **Increased inventory investment**: Companies are holding additional inventory due to unpredictable delays and congestion. Five of the businesses interviewed have invested an incremental 5-20 percent of total inventory to compensate for transportation-related delays. Both the processed food and international beverage company indicated their respective inventories were inflated 15-20 percent to compensate for transportation inefficiencies.

5. **Operational changes:** The majority of businesses interviewed (8) indicated that they have made one or more significant operational changes to compensate for Puget Sound congestion issues. Changes included:
    - Extending operating hours
    - Paying overtime
    - Using alternative delivery modes
    - Staging delivery vehicles at driver/employee homes
    - Pre-palletizing/consolidating loads to reduce driver dwell time
    - Early carrier arrival to ensure on-time pick-up and delivery
    - Pre-staging/pre-loading trucks
    - Redundant scheduling

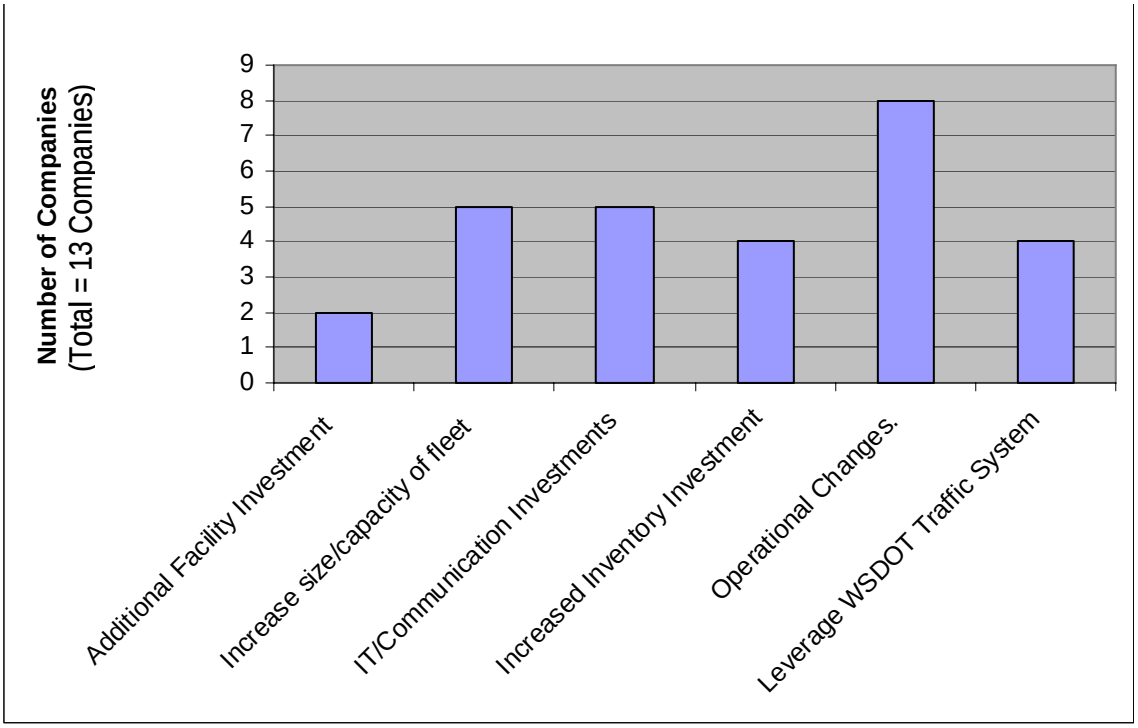
    All of these companies have adjusted operating hours in response to congestion-related issues. Bob's New Construction sends drivers home with loaded trucks for the next day's delivery to avoid employee commute as well as outbound delivery issues. After determining that peak congestion was eroding transportation efficiency by over 20 percent, U.S. Bakery converted the majority of its routes to off-peak schedules. Efficiency on those routes improved 7-10 percent, causing the company to conclude that

congestion issues are not limited to peak periods. Other changes include streamlining loading/unloading operations to minimize the truck wait times at the site/plant. This includes changes such as pre-staging loads so they are ready when the truck arrives, loading trucks the night before so they are ready to leave when the morning shift begins, and using automated loading systems.

6. **Leverage WSDOT traffic system**: Four companies regularly access the WSDOT traffic web site to assist in routing trucks. However, at least one company indicated they were often aware of traffic issues before they were reported by WSDOT.

Exhibit 12 summarizes the number of surveyed businesses that has used each of the coping strategies described above. As shown, 8 out of the 13 businesses reported making operational changes to cope with traffic congestion. The next most frequently used strategies were increased fleet size and investments in information technologies.

EXHIBIT 12
STRATEGIES USED TO COPE WITH LOCAL CONGESTION



Many of the companies included in the interviews have been able to maintain fluid operations by implementing these strategies even though congestion has increased substantially in recent years. However, there is concern that they have squeezed almost all of the inefficiencies out of their systems and it will be difficult to compensate for future increases in congestion.

EFFECT OF LAND USE PATTERNS AND GROWTH

Several interviewees observed that more industrial businesses, distribution centers, and customers are moving south of Seattle to Pierce, Thurston, and even Lewis counties. Because of traffic congestion, it is nearly impossible to serve the entire region from a single site. Therefore, the current growth trends are likely to result in two distinct market areas in the Puget Sound region: one south of Seattle and another north of Seattle. Those businesses that do not split the market and create satellite service centers may need to constrain their market size.

The growth of truck-intensive land uses in the South Puget Sound area and in Lewis County will increase the pressure on the existing freeway system and interchanges that serve these areas. South of SR 512 in Pierce County, there is only one major freeway corridor—I-5. The lack of an alternative route to this single freeway link will degrade the reliability of the freight transportation system. This link will be susceptible to delays caused by an incident or construction.

LACK OF REDUNDANCY IN FRIEGHT CORRIDORS

Beyond the immediate central Puget Sound region, all truck movements use I-5 and I-90, and neither freeway has an alternate. I-90 is problematic at all times for freight shipping because it may be closed by bad weather, avalanches, and as recently experienced, rock slides. Highway 2 over Stevens Pass is not a good alternative for interstate truck trips because of the challenging grades, two-lane configuration, and lack of connectivity with other interstate highways. Trucks experience congestion on I-5 through Lewis County (where it is two lanes in each direction), from Olympia to Everett, and through Skagit County (where it is also two lanes in each direction). I-405 provides a bypass around the worst section of I-5 through Central Seattle, but I-405 can also be extremely congested. In addition, while Highways 167 and 509 are important north-south freight routes, they do not currently connect directly to I-5 south of the Seattle, thereby minimizing their role in providing an alternate north-south route.

RELIANCE ON TRUCKING FOR INTERSTATE TRANSPORT

Most businesses interviewed use trucks to ship the majority of their materials, because trucks are generally faster than shipping by rail. For example, most components from the Midwest and East Coast are trucked to Goodrich Aircraft Technical Services, which takes five to seven days. None of these components are shipped by rail, which takes seven to ten days, plus an additional one to two days for intermodal transfer and local drayage on either end. Those requiring faster delivery are shipped by air or express carrier such as UPS, Fedex or DHL.

CHRONIC SHORTAGE OF QUALIFIED DRIVERS

Fuel costs and new qualification regulations are making it very difficult to convince truckers to move to the Puget Sound region. As a result, equipment utilization is not optimal. One trucking operation with 2,500 trucks will routinely have almost 100 trucks out of service because of this shortage of drivers.

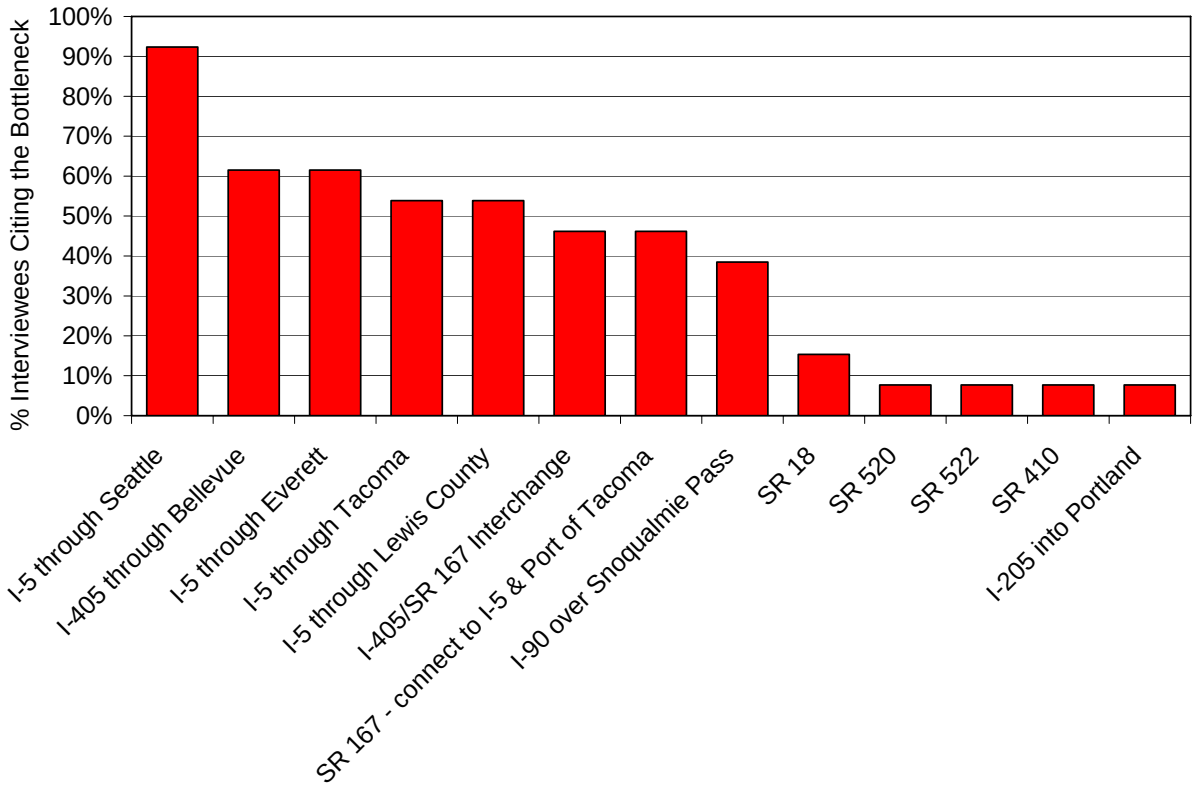
FREIGHT BUSINESS SUPPORT FOR TRANSIT INVESTMENTS

Several company representatives stated their support for light rail or other mass transit systems for commuters since it would remove trips from the highway system.

Transportation Issues

Businesses representatives were asked about transportation issues that are their top priorities to address, as well as the corridors where congestion most affects their business. Exhibit 13 lists these corridors in the order most frequently named (e.g., the first corridor was named by the most company representatives).

Exhibit 13
Worst Highway Freight Corridor Bottlenecks
Based on Industry Interviews



A map showing the location of these freight bottlenecks is included in Section 4 of this report (Exhibit 18, p. 4-8). Specific comments related to transportation operations, infrastructure, and policies were also recorded. These are listed below.

OPERATIONS

- Increased parking restrictions and reduction of truck staging and maneuvering facilities in the urban areas has caused trucks to be staged off site until space is available for loading or unloading. This is inefficient for most companies and adds to the cost of business.

INFRASTRUCTURE

- I-5 lacks a single lane that flows directly through Seattle without requiring a lane change. This creates a major bottleneck and increases the potential for accidents as trucks must merge through this section.
- It is difficult to access local ports due to congestion at the port gates and because railroads block at-grade crossings near the ports. Specific locations that were mentioned include:
    - Port of Tacoma
        - I-5 and 54th Street interchange
        - I-5 and Port of Tacoma Way interchange
        - Taylor Way and Hwy 509 intersection
    - Port of Seattle
        - West Seattle Bridge
        - Spokane Street
        - Royal Brougham Way
        - Michigan Avenue
- Major arterial connections between freeways and industrial areas should be improved. One of the major arterials mentioned is Mercer Street in Seattle, which is affected by congestion and indirect routing for trucks.
- Closing the Alaskan Way Viaduct while rebuilding it would have a significant financial burden on the Maritime Cluster businesses located on Elliott Bay and Seattle's Ship Canal.

POLICY

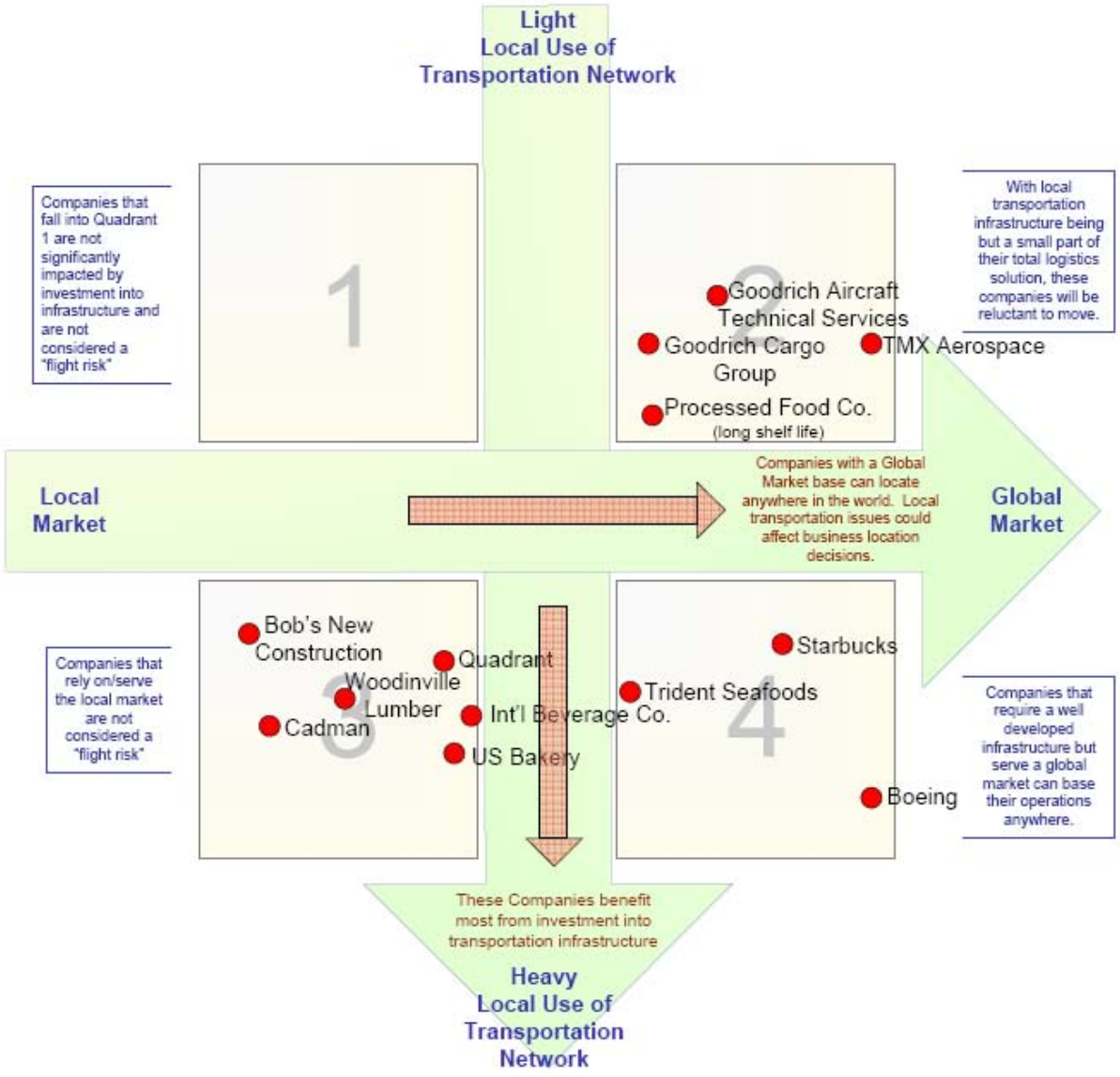
- Flatbed trucks cannot use HOV lanes, even with the required number of occupants.
- Noise restrictions prevent extending delivery times to many construction sites. This prevents construction-related businesses from increasing efficiencies by extending shipping hours.
- Restrictions and permit requirements imposed by the City of Seattle to limit construction traffic to off-peak hours have substantially increased the cost of construction in downtown Seattle. Some of these restrictions have been part of the bus tunnel closure plan, and are expected to be removed with the re-opening of the tunnel.
- There is a lack of consistent design standards for trucking corridors among various governmental agencies (i.e., city vs. state).

Response to Transportation Investment

In addition to identifying potential solutions, it is important to understand the degree to which businesses respond to investment. The information in Appendix B presents a fundamental economic principle that businesses organize their supply chains in response to their market focus (proximity to customers and suppliers) and the availability of transportation (in addition to many other factors). Using these two factors as criteria—market area and dependence on the local roadway system—the companies interviewed were classified in a basic framework, specifically based on how their supply chains are structured, that outlines their anticipated responses to investments. In addition, the data were used to determine the relative return on

transportation investments and policies. The companies were categorized according to their market focus relative to their dependence on the local transportation system, as shown in Exhibit 14, and as described in more detail below.

EXHIBIT 14
BUSINESS CLASSIFICATION
MARKET AREA VS. DEPENDENCE ON LOCAL TRANSPORTATION SYSTEM



The companies were classified across two axes. The horizontal axis is an interpretation of the target company's proximity to market, specifically local market versus global market. For example, locally based companies whose markets are completely local were graded to the left of the horizontal axis. Those whose markets are global were graded to the right of the horizontal axis. The vertical axis is an interpretation of the importance placed by the target company on

the local transportation system versus regional or global systems. The local operations which had a strong focus on local transportation were graded toward the top of the vertical axis, and those with a more global focus on transportation were graded toward the lower end of the axis.

Sector 1 (upper left corner) had no representative companies in this study. However, the types of companies that might meet this profile are local retail companies or malls that have an entirely local market, and that generate relatively few truck trips. Bellevue Square or other local retail malls would fit this profile. Local transportation investments and/or policy changes would have a minor benefit to these types of companies.

Sector 2 (upper right corner) reflects companies that have a global market, but have a low dependence on the local transportation system. These companies are located in the region because some of their customers or suppliers are located locally. Examples include large suppliers that have a global market but also have a local presence to support Boeing. The local transportation system represents a very small part of their overall global supply chain. Disruptions and inefficiencies in the local system do not have a major impact on their overall global supply chain. Moreover, they tend to have a highly sophisticated dispatch and routing system to overcome local congestion. These companies will continue to cope with local congestion, and it has a relatively small effect on their business operations. Their elasticity in response to local transportation investments or policies, or the lack thereof, is likely to be low, relative to other factors such as market access.

Sector 3 (lower left corner) reflects companies with a local or regional market focus that are highly dependent on the local transportation system. Because they are dependent on the local market, they are unlikely to move to another region due to increased congestion or other local transportation issues. However, as congestion continues to increase their transportation costs, their profits will decline. At worst, some companies may not survive. These types of companies are very dependent on local transportation, and have a relatively high elasticity in response to transportation investment, or the lack thereof. They will essentially go out of business before relocating because of transportation issues in the logistics supply chain.

Sector 4 (lower right corner) reflects companies that have locally based operations for reasons other than the local transportation system or local market. Because they have a global market focus, they have a broader range of choice in terms of location. Some of these companies may be heavily invested in the region or choose to remain in the region for a variety of other reasons. An example is Boeing. While a large portion of its supply chain is outsourced, Boeing controls the bulk of the transportation related to locally based operations, including fabrication of major components and final assembly of aircraft. Therefore the local transportation system factors significantly into the portions of the supply chain it controls. This type of company is highly elastic to local transportation investments and policies, or the lack thereof.

Based on the broad range of results and perspectives from this research, this classification system could be applied for any business in terms of anticipating the response to freight transportation investments.

Potential Solutions

Business representatives were asked for their ideas about potential transportation solutions. Suggestions voiced during the interviews are listed below. Many of these were repeated by several businesses:

1. Expand the primary highway system to provide alternative routes and/or additional lanes.
2. Set aside truck lanes along key regional corridors to provide redundancy and improve reliability of the freight system.
3. Improve regional and national rail service. Suggested improvements include providing an integrated rail system that allows seamless accounting of shipments; improving loading/off loading in the rail yards; expanding equipment to support efficient handling of small loads; and using an Integrated Information Systems infrastructure to measure on-time delivery (similar to the airlines).
4. Implement toll facilities for truck use if they increase the capacity for freight. Companies will adapt to include tolls in transportation pricing. If it decreases travel time and increases reliability, tolled facilities could even reduce the overall transportation costs for some businesses.
5. Improve the ability to stage trucks in urban areas where local agencies want to impose parking and loading restrictions, either through policy changes or additional trucking facilities.
6. Expand the area covered by WSDOT's traffic web site to include areas north and south of King County and additional highways.
7. Improve cycle times through the seaports.
8. Consider daytime incident management along major corridors, in addition to peak-hour response.
9. Establish state-wide standards for regional trucking corridors (e.g., lane widths, turning radius, etc.) and prevent local municipalities from superseding state-defined standards.
10. Allow trucks to use HOV lanes regardless of the number of occupants.
11. Encourage local retailers to accommodate off-hour deliveries (from 6:00 P.M. to 3:00 A.M.) to relieve daytime congestion on the roadways and improve efficiency of delivery.
12. Review logistics infrastructure between the seaports and the rail heads to identify and reduce congestion points between the two systems.

Section 4
Specific Constraints, Opportunities, & Recommendations

Introduction

This section of the report outlines the constraints and opportunities for improving the reliability, cost, and competitiveness of the targeted supply chains, as well as recommendations for specific actions that WSDOT and potential partners could pursue. It follows a three-step outline:

1. **Discuss performance measures** that are important to each of these supply chains.
2. **Show truck concentrations** and their relationship to transportation system constraints.
3. **Recommend actions** to address transportation system constraints.

The recommendations are presented as priority actions and other actions, and are further grouped into three categories:

- Operational
- Infrastructure
- Policy

A specific set of constraints/opportunity pairs are outlined for each of these categories. Most of these are drawn from the previous section. A determination was made not to bring in outside sources (i.e., truck trip data, congestion data, etc.) as this goes beyond the scope and intent of this report.

Supply Chain Performance Measures

In order to determine deficiencies in the freight delivery system, it is vital to know what performance measures are most important to the users. A major goal of this study was to determine which performance measures matter the most to major Puget Sound manufacturers. Throughout the interview process, two overriding performance measures became clear:

- Total Delivered Cost (TDC)
- Transportation system performance and reliability

TOTAL DELIVERED COST

Manufacturing companies typically employ a standard metric termed "Total Delivered Cost" (TDC) to gauge their competitiveness in the marketplace or to track their own efficiencies and efforts to improve. Each company has a different sensitivity to fluctuations in transportation costs. Increased transportation costs could be catastrophic for one company and not be noticed by another due to the relative contribution of transportation costs to TDC.

As stated in Section 3 of this report, our study found that when companies manufacture products that have a high "cost of goods," the relative transportation costs are low and thus less important. An example is an aircraft component. Conversely, companies with a low "cost of goods," like a bakery, are very sensitive to rising transportation costs (see Exhibit 11, p. 3-4).

Because of this, each company will address and leverage opportunities differently, based on management ability, worker skills, technical knowledge, availability of resources, and company infrastructure. Transportation costs are a common denominator in this equation for all manufacturing companies in the Central Puget Sound region. Improving the transportation infrastructure within the Puget Sound region would positively impact all area companies.

Each company interviewed has a certain number of variables that they can control or influence in order to improve their transportation costs or efficiencies. These improvements generally come as a result of innovation, experience, use of technology, or employment of additional resources. Each company's response to its challenges followed a generally defined decision tree that could be summarized as follows:

- Meet the needs of the business—this is the primary driver
- Minimize costs/use of resources
- Seek additional information to facilitate further adaptations and coping strategies
- Seek additional resources
- Evaluate alternate locations

As one might expect, each company attempts to solve its problems differently, striving for the best fit for its own requirements.

Nonetheless, regardless of the relative effect of transportation costs, companies strive to minimize their costs in order to remain competitive. This includes reducing transportation costs wherever possible. One of the key contributing factors that affect transportation cost is the reliability of the transportation system itself. While companies have control over some factors that influence transportation costs, they do not have influence over the transportation system's reliability. For example, they can negotiate lower transportation costs with their suppliers, they can choose lower cost nodes, or they can locate closer to their markets to reduce transportation costs. However, locally based manufacturers do not control the reliability of the transportation system.

Transportation system reliability, or performance, can affect transportation costs, and hence total delivery costs in a variety of ways.

- **Increased Equipment and Operating Costs:** Increased congestion in the highway system increases travel time, forcing companies to buy more equipment and hire more drivers.
- **Increased Inventory Costs:** A reduction in reliability forces companies to hold more inventory. Some companies interviewed have resorted to Just-In-Case (JIC) inventory management practices whereby they hold extra stock/inventory to cover for deliveries that do not meet production schedules. Some businesses interviewed have invested an incremental 5-20 percent of total inventory to compensate for transportation-related delays.
- **Satellite Operations:** Due to increased congestion and increased trip times, some businesses have been forced to split their market areas and have built smaller satellite operations to serve the split markets. This increases the cost of providing services.

- **Invest in Technology:** In order to make better routing decisions to avoid congestion and to make up for a longer trip times, companies are investing in expensive technology innovations.

Given that transportation system performance is a factor that influences total delivery cost and is outside of the control of the locally based industries, it is important that this study provide further insight into transportation system performance.

TRANSPORT SYSTEM PERFORMANCE AND RELIABILITY

The key finding of this study is that the target supply chains rely significantly on the highway system. The local and regional highway systems play a dominant role in supporting the target supply chains. However, the local and regional highway systems also present the most significant challenge to the reliability of the target supply chains.

Based on the interviews, congestion and reliability along the Puget Sound region's highway system has led to a deterioration in highway travel times. Some of the interviewees concluded that the average truck trip time has increased by between 30 percent and 50 percent over the past three to five years. Moreover, interviewees stated that the highway system in general is more unpredictable, specifically during peak hour periods. This assertion is further supported by results from the 2001 Central Puget Sound Urban Freeway Network Usage and Performance study, conducted by the Washington State Transportation Center (TRAC). Exhibit 15 identifies regional roadways with significant variances in average trip times during the average AM Peak, Midday and PM Peak weekday travel periods. While the data are somewhat dated (2001), and are not for the entire highway system, it does support the assertions by the supply chain interviewees that travel times on the highway system are unpredictable. The data indicate that the AM peak, PM peak, and Midday peak periods are all unreliable, with the PM peak being perhaps the worst of the three.

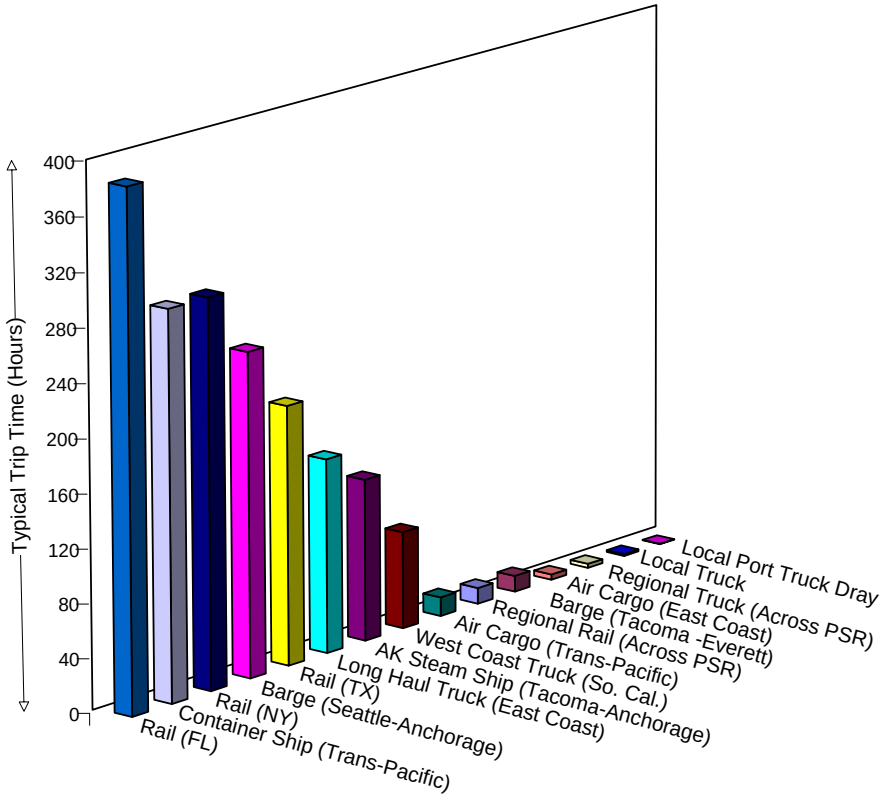
EXHIBIT 15
ROADWAY SEGMENTS WITH HIGH TRIP TIME VARIANCE

Freeway	Segment	Direction	Variance (Greater than 40%)		
			AM Peak	Noon	PM Peak
I-5	Everett to Seattle	South	55%	50%	41%
		North			45%
	Sea-Tac to Seattle CBD	South			48%
		North		44%	47%
I-90	Issaquah to Seattle CBD	West	48%		65%
		East			57%
I-405	231st Street SE to Bellevue CBD	South	41%		
		North			46%
	Tukwila to Bellevue CBD	South		41%	46%
		North			
SR-167	Auburn to Renton	South			81%
		North	47%		

Large trip time variances on the highway system have significant implications for the target freight supply chains. A disproportionately high number of trips for the target supply chains occur on the highway system. Almost every shipment for a Puget Sound-based supply chain has at least two segments or "legs" that occur on the region's highway system. Therefore, highway travel time reliability impacts every supply chain shipment. Second, highway mode segments are the most sensitive to variance, compared to any other mode segment along the supply chain. To understand this point, it is important to first compare the typical trip times for the various modal segments.

Exhibit 16 shows that the typical trip time varies significantly for each of the different mode segments across the supply chain. For example, the typical travel time for an airplane component shipped by rail from a supplier in Florida is sixteen days. A shipment by ocean container from Asia takes ten to twelve days. On the other extreme, a local highway trip can be an hour or less. These typical trip times are factored into the supply chain decision process. Therefore, the length of the trip time does not necessarily impact the supply chain as long as the trip time is constant. Variance in trip time is much more of an impact to the supply chain.

EXHIBIT 16
THE TYPICAL TRIP TIMES BY MODE



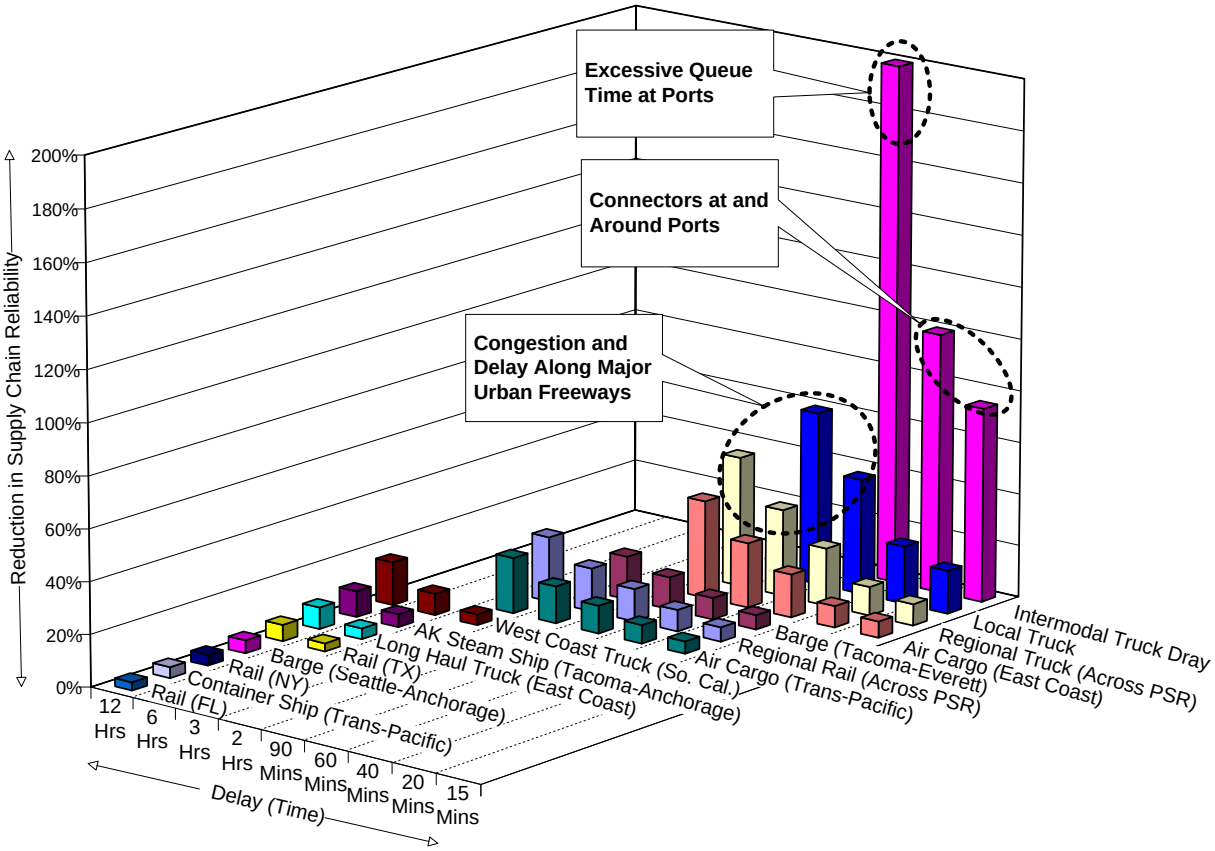
Source: Trip times based on industry interviews.

The modal segments that have the longer typical trip times offer supply chain managers the flexibility to factor in extra time to accommodate delay that may occur along the trip. The longer the trip time, the greater the opportunity for including extra time to account for delays.

Conversely, because of the shorter time and distance traveled on the highway system, any amount of delay results in a significant level of variance. Truck trips tend to be faster and require a greater deal of precision in terms of managing on-time reliability.

Exhibit 17 compares the impact of delay on the various modal segments of the supply chain. It illustrates the impact of a representative range of delay times and the impacts on trip variance.

EXHIBIT 17
IMPACT OF DELAY ON SUPPLY CHAIN RELIABILITY (BY MODE)



Source: Trip times and delay based on industry interviews.

The key conclusion that can be drawn from the graph is that a relatively small amount of delay has a far more significant impact on highway-based trips than trips by other modes such as rail or ship. For instance, a 40-minute delay results in a 22 percent variance for a delivery traveling across the Puget Sound region, a 44 percent variance for a locally based delivery, and a 200 percent variance for a short trip from the Port of Seattle to the Kent valley. However, a 40-

minute delay has less impact on the variance of a marine shipment or rail shipment. The scheduled delivery window for a marine shipment is typically within a 24-hour target period.

Marine shipping line schedules target a general day of the week, as opposed to a specific hour within a specific day. In order for an occurrence in delay along a marine modal segment to even affect the reliability of the supply chain, it has to approach a delay period of 24 hours or more. On the other hand, the delivery window for truck shipment is measured in minutes and hours, not days. Delays measured in minutes can have a significant impact on supply chain reliability.

The findings from the 2001 TRAC study cited earlier further support the assertion that the deteriorating reliability in the Puget Sound region's highway system has the most significant impacts on the target supply chains. Based on the TRAC study, there are several highway segments with trip variances in the 40 percent to 60 percent range, and as high as 80 percent. As shown Exhibit 16 above, highway congestion and delay reduce supply chain reliability within a similar range (40 percent to 60 percent). Delay occurring along arterial connectors reduces the reliability of port-related truck trips by as much as 80 percent to 100 percent. Excessive queuing times for trucks at port gates can reduce supply chain reliability by up to 200 percent. In general, however, port-related truck trips are a disproportionately smaller share of overall truck trips.

Truck Concentrations and System Constraints

Having established that highway systems reliability is the leading issue for industries that rely on locally based transportation, it is important to provide insight about where potential solutions may have the greatest impact, currently and in the future. This kind of insight is important for agencies that provide transportation infrastructure, such as WSDOT. With a limited amount of resources and capital, it is important to invest freight-specific resources where they are likely to have the greatest effect.

FREIGHT ACTIVITY CENTERS

One method by which to gauge the most vital links in the freight delivery system is to determine the major freight "activity centers." Activity centers will be the major production and attraction sites for all truck trips, and therefore the links between activity centers are often the most vital to the transportation system as a whole. Activity centers investigated in this study fall into the following categories:

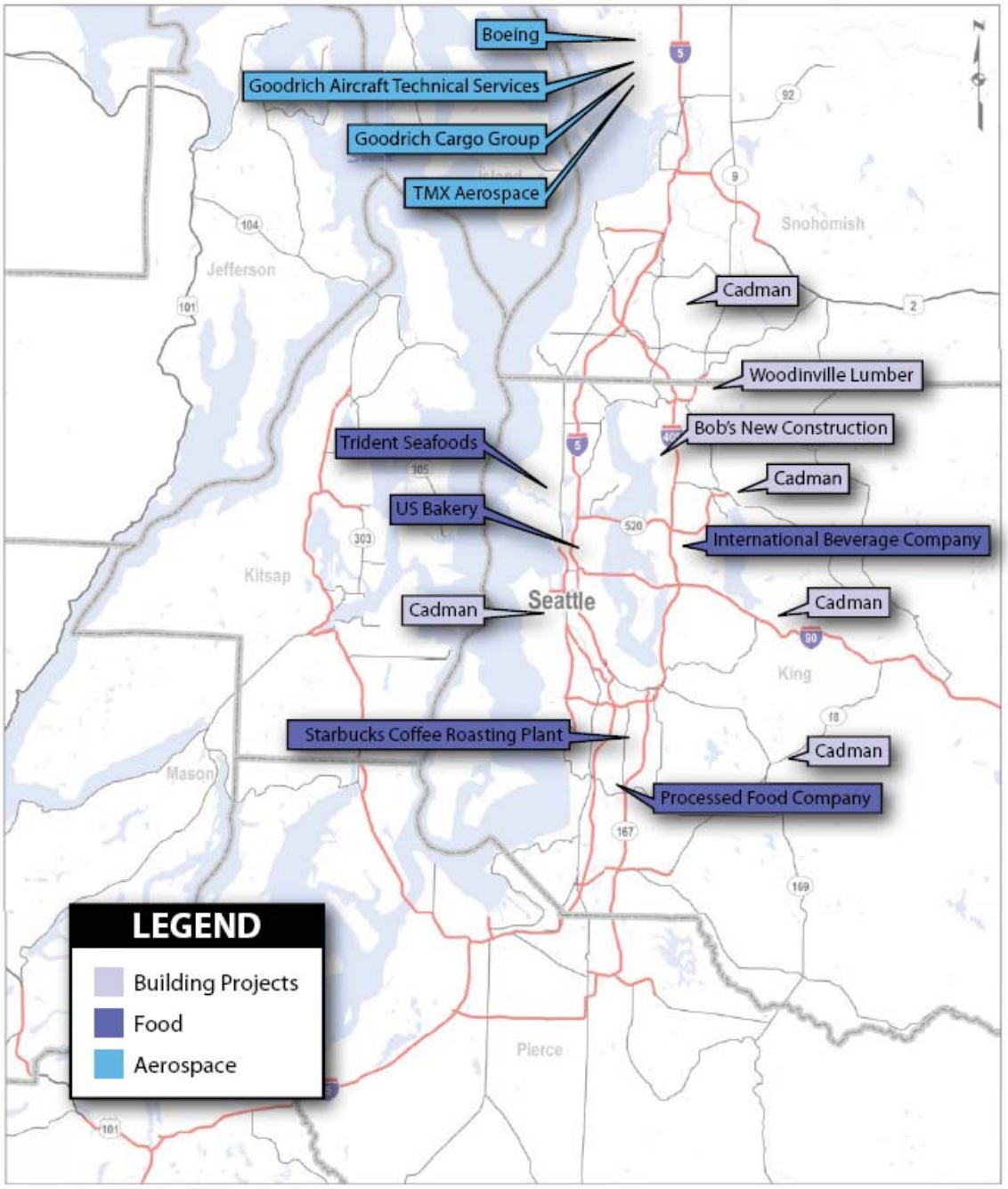
- Entry ports into the region
- Central distribution centers
- Manufacturing locations
- Packaging and bottling facilities
- End users (work site, factory, shipping point, or vendor)

The interview process undertaken for this study was an effort to fairly assess the important transportation links to major Puget Sound regional industries. Therefore, specific questions about the major activity centers were asked, as well as specific questions about perceived sections of bottlenecks and congestion along Puget Sound roadways. The results of these questions reveal which segments of roadway are vital to major industries in the region.

Major Manufacturing Centers

Exhibit 18 shows the geographical distribution of the companies interviewed in this effort. This includes the major manufacturers in the processed food industry, the building and construction industry, and the aerospace industry. It also includes the secondary and tertiary suppliers that were included in the interview process.

EXHIBIT 18
PUGET SOUND MANUFACTURING LOCATIONS OF COMPANIES INTERVIEWED



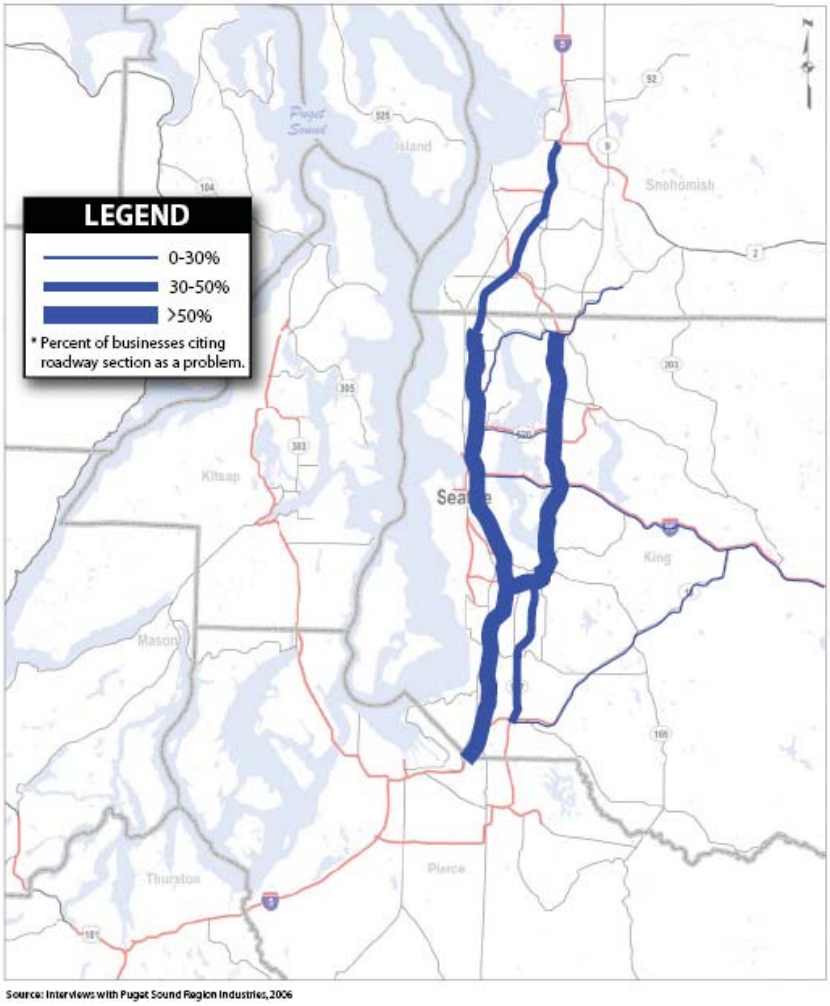
Source: Stakeholder Interviews 2006

The companies interviewed represent a fairly even distribution of industries throughout the Puget Sound region, extending as far north as Everett and as far south as Kent. For those companies clustered around Seattle, there is a fairly even distribution west of Lake Washington (along I-5) and east of Lake Washington (along I-405). There are also some companies along the SR 520, the SR 18, and the I-90 corridors.

Links with High Truck Movements

The physical location of the interviewed companies provides some indication of critical transportation links for inbound and outbound shipments. The locations indicate that the companies are clustered around the major links identified above, in particular the north-south I-5 and I-405 corridors. The interview process corroborated this impression of critical links. When asked to describe the "worst bottleneck" affecting their business (i.e., the segments that each company would most like to improve), over 90 percent mentioned I-5 and over 60 percent mentioned I-405. Exhibit 19 graphically depicts the proportion of the respondents who identified a particular roadway segment. The exact percentages can be found in Exhibit 12 (p. 3-9) of this report.

EXHIBIT 19
HIGHWAY FREIGHT CORRIDOR BOTTLENECKS



Source: Interviews with Puget Sound Region Industries, 2006

Existing and Future Puget Sound Region Industrial and Warehouse Space

Though existing freight activity centers were determined in part from industry interviews, it was also deemed necessary to research the square footages of warehouse and industrial space in the Puget Sound region. The purpose of this analysis was to identify trends that point to future concentrations in freight activity. Therefore, research was conducted as to the amount of space devoted to "Existing" warehouse and industrial space as well as that "Under Construction." The data used for this analysis were available for specific geographic areas, namely the Northend, Seattle, Eastside, Tacoma, and Southend markets, as noted in the following sections and depicted in Exhibits 20 and 21 below.

EXISTING DISTRIBUTION

As shown in Exhibit 20 on p. 4-10, the distribution of existing space devoted to industrial uses favors the Southend of Puget Sound and Seattle markets, with 38 percent and 23 percent, respectively, of the existing market. Tacoma and the Northend each have about 16 percent of the existing market, and the Eastside has about 7 percent. This supports the fact that much of the region's freight moves between activity centers in the Southend and Seattle, with additional movements between Tacoma and the Northend.

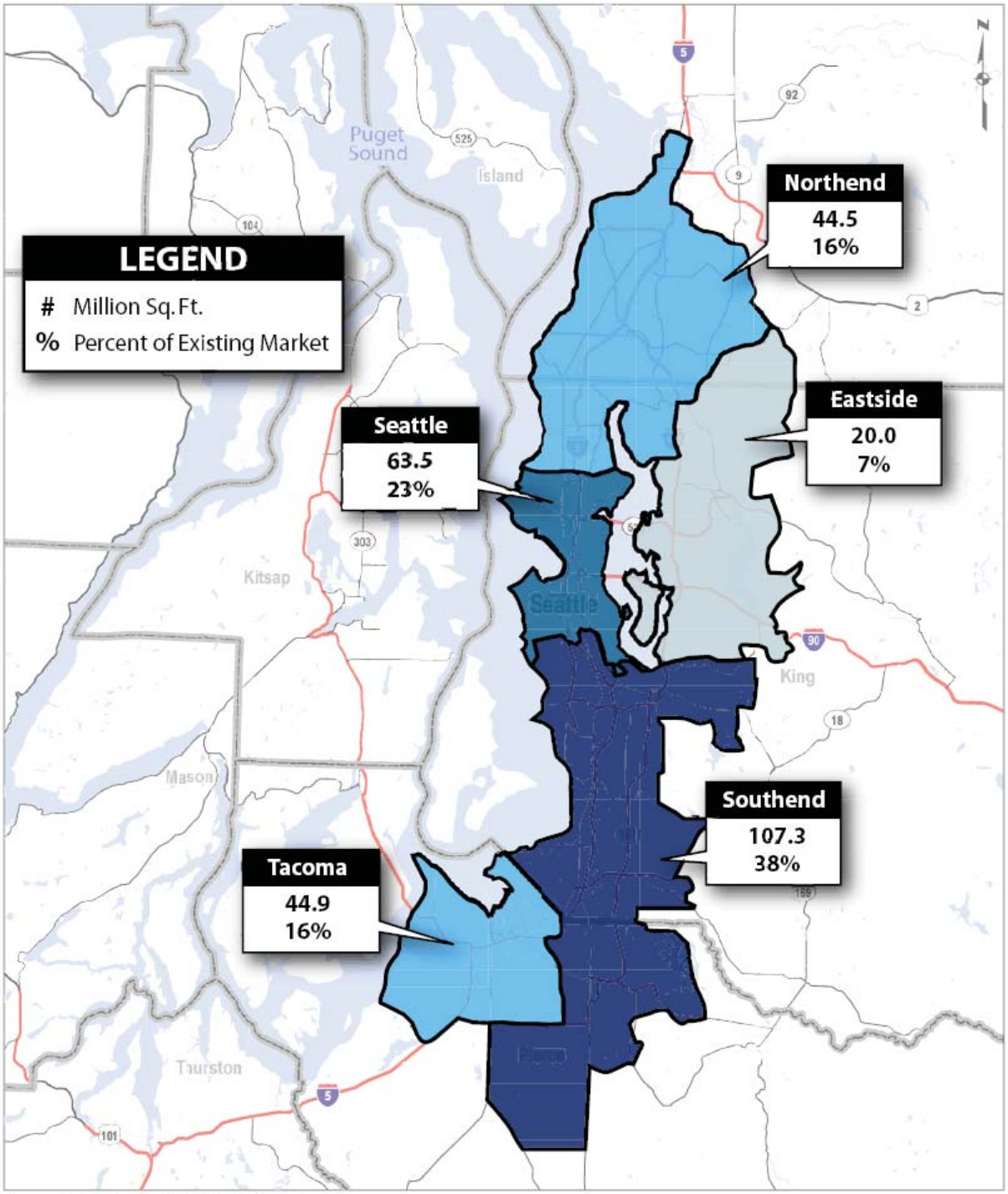
FUTURE DISTRIBUTION

Another input for determining critical roadway links is identifying where future activity centers will be. With this information, it may be possible to anticipate growth with enough certainty to implement infrastructure improvements to support the growth in a timely manner. For this reason, this study researched future expansion trends of warehouse and industrial space. Specifically, market data indicate that slightly over 3.8 million square feet is permitted and under construction as of 2005 (see Exhibit 21 on p. 4-11).

The key finding from the data is that there is a significant shift towards the markets south of Seattle. In fact, 65 percent of the 3.8 million square feet under construction is in Tacoma, with an additional 26 percent in the Southend. This represents 91 percent of all new space under construction. The Eastside will see a 6 percent increase in space, with the Northend seeing the remaining 3 percent. No new industrial or warehouse space is under construction in Seattle. This is likely due to the high cost of land in Seattle, and the availability of existing warehouse space there.

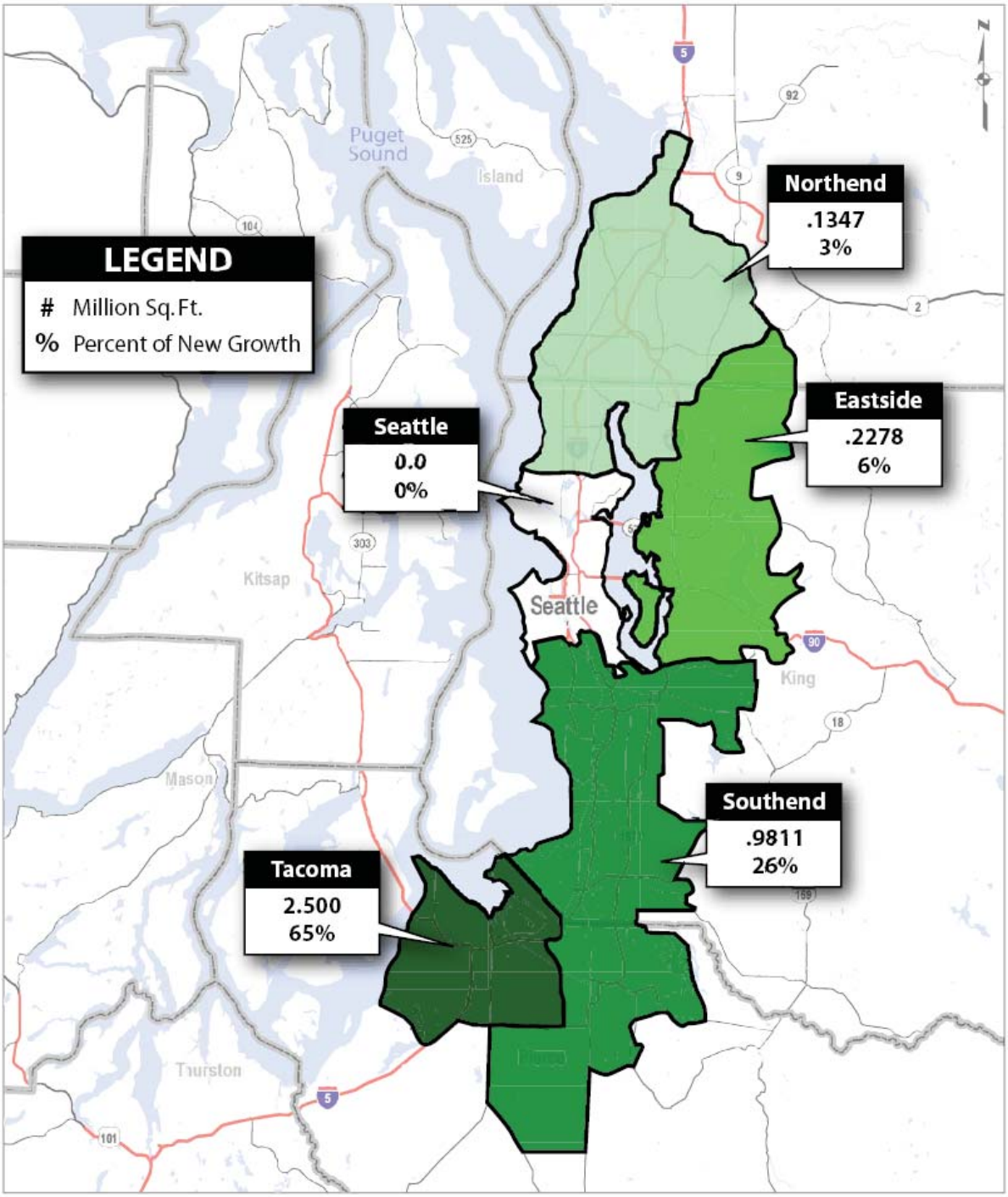
This analysis of future industrial and warehouse space illustrates a distinct move south, away from Seattle and towards the areas of Kent, Auburn, Federal Way, and Tacoma. For this reason, the conclusions of this report emphasize the infrastructure that feeds these southern regions. The findings of this review are reflected in the "Priority" recommendations made later in this report.

Exhibit 20
Existing Industrial/Warehouse Space (2005)



Source: COSTAR Group, Inc. COSTAR Industrial Report, Year-end 2005- Seattle/Puget Sound

Exhibit 21
Industrial/Warehouse Space Under Construction (2005)



Source: COSTAR Group, Inc. COSTAR Industrial Report, Year-end 2005- Seattle/Puget Sound

Recommended Actions

The conclusions of this report are meant to help direct freight finance and planning decisions during future Washington State Department of Transportation strategic plans. To this end, it was deemed most useful to divide recommendations into two categories, "Priority" and "Other." Within these two categories, they are further divided into operational improvements, capital improvements, and policy recommendations.

PRIORITY ACTIONS

The manufacturing industry in the Central Puget Sound region would benefit most from the following high priority actions to improve freight movements. These recommendations are based on the findings of the targeted industry surveys and on the technical expertise of the consulting team. The projects are directed at improving mobility for the industrial and manufacturing businesses located within the Central Puget Sound region. Two of the actions listed below are operational measures that can be implemented in the short-term. The others are longer-term capital improvements.

1. Expand WSDOT's Web-based traffic flow map to provide better traffic flow information and camera coverage in the urban area as well as to expand the network beyond the current limits. Some of these locations are already in the capital budget, including:
   - I-5 between Federal Way and Tacoma
   - SR 516 between I-5 and SR 167

   Other locations are recommended, including:
   - I-5 south to Lewis County (and perhaps through Centralia)
   - I-5 north of Everett through Skagit County (includes remaining two-lane section in Mount Vernon in preparation for additional congestion that could occur in 2010 for the Vancouver Olympics)
   - SR 167 south of Auburn
   - I-90 between Issaquah and North Bend
   - SR 18 (adding cameras)
   - SR 169 near I-405

2. Increase incident response along major freight corridors, and expand hours to include midday. Major corridors include:
   - I-5 from Seattle to Lakewood
   - SR 167 from Renton to Puyallup
   - SR 599 from 1st Avenue S Bridge to I-5
   - I-90 from Seattle to Issaquah

   Some of these are already included in the capital budget, including:
   - Funding for one additional patrol in the south end of I-405 during peak traffic congestion (including the SR 167 interchange)
   - Funding for two additional patrols during peak traffic congestion on Highway 18 and in south King County

3. Complete missing links on missing freight routes to improve connectivity and reliability for freight. The highest priority freight routes to improve the reliability for Central Puget Sound manufacturing are:
    - SR 167 from I-5 to SR 161, with a direct connection between SR 167 and I-5. The extension was proposed to be funded in past iterations of the Regional Transportation Investment District (RTID); however, the interchange with I-5 was not funded. In order for this project to serve regional freight needs between the customers and manufacturing centers, a connection to SR 167 is needed.
    - SR 509 from S. 188th Street to I-5. This project was proposed to be funded in past iterations of the RTID. This project will benefit freight by creating a parallel route to I-5 that connects from Seattle's Duwamish Industrial Area to the Kent Valley. In addition to relieving congestion on this critical section of I-5, the SR 509 project will also provide an alternate route to improve the reliability of the entire system.

4. Increase capacity along major freight routes. These include
    - I-5 from Mercer Street to the Boeing Access Road. Capacity increases may be possible by improving the ramp weave-merge section between the West Seattle Freeway and I-90 and by reconfiguring ramp access to and from downtown Seattle. There is no concept or funding for potential improvements in this section.
    - SR 167 from I-405 to Sumner. HOV and ramp improvements are proposed as part of the SR 167 Corridor project. Partial funding for this project has been provided by the "Nickel Account" with the remaining funds proposed in past iterations of the Regional Transportation Improvement District (RTID).

OTHER FREIGHT PROJECTS

There are many other projects that would enhance freight mobility for industrial and manufacturing businesses in the State of Washington. The list below is also based on the targeted industrial sector surveys. These are listed below by type of project: Operational, Infrastructure, and Policy.

Operational

1. Reduce disincentives to delivering at night (from 7:00 P.M. to 7:00 A.M.) to relieve daytime congestion on the roadways and improve efficiency of delivery.

2. Consider incentive programs, such as PierPass in Los Angeles/Long Beach, that would shift Port truck traffic to nighttime hours.

3. Allow trucks to bypass ramp meters at locations with high truck volumes and steep grades or short merge lengths.

Infrastructure

4. Replace failing infrastructure that, if lost, would dramatically affect capacity on the major freight routes of I-5 and I-405. This includes replacing the Alaskan Way Viaduct and SR 520 Bridge. Funding for these projects is expected to be from a mix of local, state, and federal funding options.

5. Improve I-90 to reduce weather-related closures and increase capacity over Snoqualmie Summit. This project has been funded out of the 2005 Transportation Partnership Account.

6. Complete planned major truck linkages to the Port of Seattle and Port of Tacoma. Specific projects include:
   - SR 519 Phase 2
   - Spokane Street Viaduct Project (widening and ramp improvements are currently unfunded)
   - East Marginal Way Grade-Separation Project (funded)
   - Lincoln Avenue Grade-Separation Project (partially funded, currently in design)
   - Port of Tacoma Road Interchange Improvements (being considered as part of I-5 mainline improvements through Fife.)

7. Increase capacity on I-5 from Fife to Fort Lewis. A portion of the project–from Port of Tacoma Road to Pacific Avenue in Tacoma–is proposed as part of an "Add HOV Lanes" project, which received partial funding from the 2005 Transportation Partnership Account and was fully funded in past iterations of the RTID proposal. A separate project being constructed as part of the I-5/SR 16 interchange improvements would extend the HOV lanes to SR 16. An extension further south is not yet funded.

8. If additional HOT lane or other managed lane programs are implemented, infrastructure improvements such as direct access ramps that would improve truck access into the lanes should be considered.

Policy

9. Establish state-wide standards for regional trucking corridors (e.g., lane widths, turning radii, etc.) and prevent local municipalities from superseding state-defined standards.

10. Create a direct funding stream for improvements to arterial truck routes that provide access to I-5, I-405, SR 167, SR 99, and SR 18. This funding mechanism could use the existing State's Freight and Goods Transportation System (FGTS) Classifications for "T-1" and "T-2" routes.

11. Update FGTS route maps on an annual basis. Ensure continuity in the route classifications between jurisdictions. These maps are currently updated every two years by the state, but could benefit from a yearly update.

12. Consider reducing tolls (e.g., on Tacoma Narrows Bridge) for trucks that move at night.

13. Increase driver training programs. Work with Homeland Security to increase the pool of drivers eligible to move restricted commodities.

14. Consider programs that would reduce cost to individual driver-owners, such as insurance pools and shared maintenance programs.

SUMMARY

All companies surveyed found the use of the Puget Sound area transportation infrastructure challenging. In addition, all companies surveyed are experiencing increased costs related to transportation. Those costs are growing at a faster rate than volumes and revenue. Finally, each company responds to the challenge in different ways, but they all use similar criteria or guidelines when formulating a response to transportation challenges.

As a result of the study and through the many interviews conducted with supply chain personnel and management of the sample companies, it became apparent that some of the possible solutions to the challenges faced by these companies were either unrealistic (i.e., solutions that were outside their sphere of influence or ability to control) or they could not be completed in a time frame that would meet their short-term needs.

Additional infrastructure (e.g., expanded interstate highways, transportation corridors, alternate routes, and toll ways) to remedy key bottlenecks or capacity issues are already in the planning stages in many instances. Although commonly cited as being most beneficial, these solutions are both expensive and time-consuming.

Each company surveyed, and by inference most manufacturing companies in the region, has logistic solutions that are unique to it alone. This is driven by the many variables in the components of the TDC for each product manufactured. What is important to one company may not be as important to another company. The resources available to solve a particular problem are likely to be allocated differently in individual companies, or the relative cost of transportation to the cost of goods may be so high as to demand more immediate or aggressive solutions.

The team found that, given sufficient information, each company is developing its own ways to cope. Just as each company employs all its resources, skills, experience, and technology to best meet the objectives of business and does so in a way that is different from its competitors, these companies can continue to find ways to overcome the challenges and costs of their supply chains.